

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
18 January 2001 (18.01.2001)

PCT

(10) International Publication Number  
WO 01/04118 A2(51) International Patent Classification<sup>7</sup>: C07D 453/02(74) Agent: GOLDIN, Douglas, Michael; J.A. Kemp & Co.,  
14 South Square, Gray's Inn, London WC1R 5EU (GB).

(21) International Application Number: PCT/EP00/06469

(22) International Filing Date: 7 July 2000 (07.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.(30) Priority Data:  
P 9901580 14 July 1999 (14.07.1999) ES(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).(71) Applicant (*for all designated States except US*): ALMIRALL PRODESFARMA S.A. [ES/ES]; General Mitre, 151, E-08022 Barcelona (ES).

(72) Inventors; and

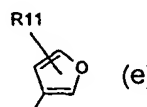
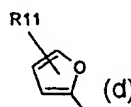
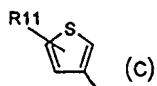
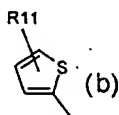
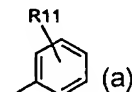
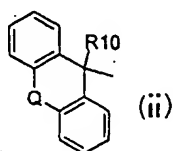
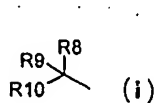
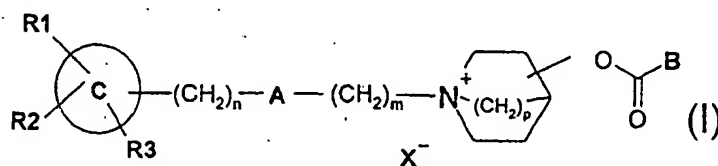
(75) Inventors/Applicants (*for US only*): FERNANDEZ FORNER, Dolors [ES/ES]; Roget de Flor, 221, 5<sup>o</sup>-4<sup>a</sup>, E-08025 Barcelona (ES). PRAT QUIÑONES, Maria [ES/ES]; Andrea Doria, 2, 1<sup>o</sup>-1<sup>a</sup>, E-08003 Barcelona (ES). BUIL ALBERO, Maria Antonia [ES/ES]; Calle Paris, 50, 1<sup>o</sup>-4<sup>a</sup>, E-08029 Barcelona (ES).

Published:

— Without international search report and to be republished upon receipt of that report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: NOVEL QUINUCLIDINE DERIVATIVES AND MEDICINAL COMPOSITIONS CONTAINING THE SAME



(57) Abstract: A compound according to formula (I) wherein z<sup>⊙</sup> is a phenyl ring, a C<sub>4</sub> to C<sub>9</sub> heteroaromatic compound containing one or more heteroatoms, or a naphthalenyl, 5,6,7,8-tetrahydronaphthalenyl or biphenyl group; R<sup>1</sup>, R<sup>2</sup> and R<sup>3</sup> each independently represent a hydrogen or halogen atom, or a hydroxy group, or a phenyl, -OR<sup>4</sup>, -SR<sup>4</sup>, -NR<sup>4</sup>R<sup>5</sup>, -NHCOR<sup>4</sup>, -CONR<sup>4</sup>R<sup>5</sup>, -CN, -NO<sub>2</sub>, -COOR<sup>4</sup> or -CF<sub>3</sub> group, or a straight or branched lower alkyl group which may optionally be substituted, for example, with a hydroxy or alkoxy group, wherein R<sup>4</sup> and R<sup>5</sup> each independently represent a hydrogen atom, straight or branched lower alkyl group, or together form an alicyclic ring; or R<sup>1</sup> and R<sup>2</sup> together form an aromatic, alicyclic or heterocyclic ring; n is an integer from 0 to

4; A represents a -CH<sub>2</sub>-, -CH=CR<sup>6</sup>-, -CR<sup>6</sup>=CH-, -CR<sup>6</sup>R<sup>7</sup>-, -CO-, -O-, -S-, -S(O)-, SO<sub>2</sub> or NR<sup>6</sup>- group, wherein R<sup>6</sup> and R<sup>7</sup> each independently represent a hydrogen atom, straight or branched lower alkyl group, or R<sup>6</sup> and R<sup>7</sup> together form an alicyclic ring; m is an integer from 0 to 8; provided that when m = 0, A is not -CH<sub>2</sub>-; p is an integer from 1 to 2 and the substitution in the azoniabicyclic ring may be in the 2,3 or 4 position including all possible configurations of the asymmetric carbons; B represents a group of formula (i) or (ii), wherein R<sup>10</sup> represents a hydrogen atom, a hydroxy or methyl group; and R<sup>8</sup> and R<sup>9</sup> each independently represents formulae (a), (b), (c), (d) and wherein R<sup>11</sup> represents a hydrogen or halogen atom, or a straight or branched lower alkyl group and Q represents a single bond, -CH<sub>2</sub>-, -CH<sub>2</sub>-CH<sub>2</sub>-, -O-, -O-CH<sub>2</sub>-, -S-, -S-CH<sub>2</sub>- or -CH=CH-, and when (i) or (ii) contain a chiral centre they may represent either configuration; X represents a pharmaceutically acceptable anion of a mono or polyvalent acid, which shows high affinity for muscarinic M<sub>3</sub> receptors (Hm3).

WO 01/04118 A2

NOVEL QUINUCLIDINE DERIVATIVES AND MEDICINAL COMPOSITIONS  
CONTAINING THE SAME

5 This invention relates to new therapeutically useful quinuclidine derivatives, to some processes for their preparation and to pharmaceutical compositions containing them.

The novel structures according to the invention are antimuscarinic agents with a potent and long lasting effect. In particular, these compounds show high affinity for muscarinic  $M_3$  receptors (Hm3).

10 In accordance with their nature as  $M_3$  antagonists, the new compounds are suitable for treating the following diseases: respiratory disorders such as chronic obstructive pulmonary disease (COPD), chronic bronchitis, bronchial hyperreactivity, asthma and rhinitis; urological disorders such as urinary incontinence, pollakiuria in neuripenia pollakiuria, neurogenic or unstable bladder, cystospasm and chronic cystitis; and gastrointestinal disorders such as irritable bowel syndrome, spastic colitis, diverticulitis and peptic ulceration.

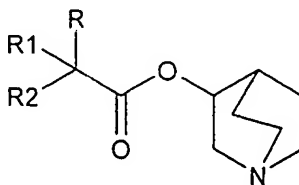
20 The compounds claimed are also useful for the treatment of the respiratory diseases detailed above in association with  $\beta_2$  agonists, steroids, antiallergic drugs or phosphodiesterase IV inhibitors.

Compounds of the present invention may also be expected to have anti-tussive properties.

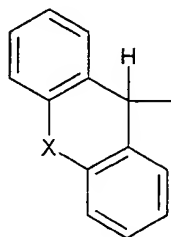
25 Depending on their nature the new compounds may be suitable for treating vagally induced sinus bradycardia.

Compounds with related structures have been described as anti-spasmodics and anti-cholinergic agents in several patents.

For example, in patent FR 2012964 are described quinuclidinol derivatives of the formula

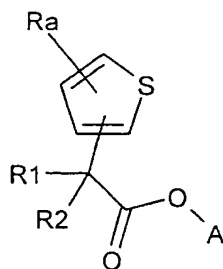


in which R is H, OH or an alkyl group having 1 to 4 carbon atoms; R<sub>1</sub> is a phenyl or thienyl group; and R<sub>2</sub> is a cyclohexyl, cyclopentyl or thienyl group, or, when R is H, R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a tricyclic group of the formula:

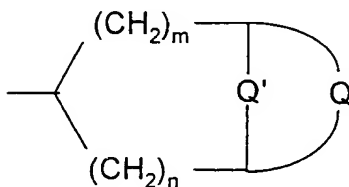


5 in which X is -O-, -S- or -CH<sub>2</sub>-, or an acid addition or quaternary ammonium salt thereof.

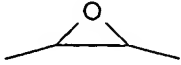
EP- 418716 describes thienyl carboxylate esters of formula



wherein A is a group

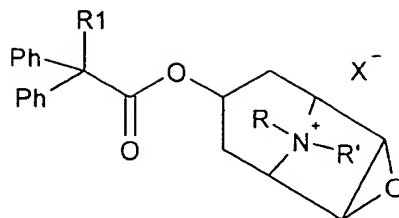


m and n = 1 or 2

10 Q is a -CH<sub>2</sub>-CH<sub>2</sub>-, -CH<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>-, -CH=CH-,  group

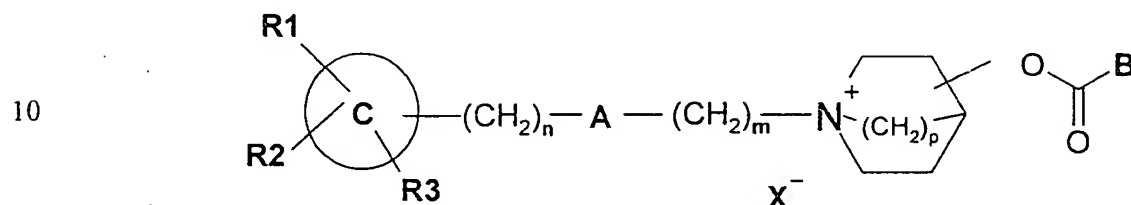
Q' is a =NR or NRR' group; R<sub>1</sub> is a thienyl, phenyl, furyl, cyclopentyl or cyclohexyl group, optionally substituted; R<sub>2</sub> is H, OH, C<sub>1</sub>-C<sub>4</sub> alkoxy or C<sub>1</sub>-C<sub>4</sub> alkyl and R<sub>3</sub> is H, F, Cl, CH<sub>3</sub>- or -NR.

15 US 5,654,314 describes compounds of formula:



wherein R is an optionally halo- or hydroxy-substituted  $C_{1-4}$  alkyl group; R is a  $C_{1-4}$  alkyl group; or R and R' together form a  $C_{4-6}$  alkylene group;  $X^-$  is an anion; and  $R_1$  is H, OH,  $-CH_2OH$ ,  $C_{1-4}$  alkyl or  $C_{1-4}$  alkoxy.

The present invention provides new quinuclidine derivatives with potent antagonist activity at muscarinic  $M_3$  receptors which have the chemical structure described in formula (I):



(I)

wherein:

© is a phenyl ring, a  $C_4$  to  $C_9$  heteroaromatic group containing one or more heteroatoms (preferably selected from nitrogen, oxygen and sulphur atoms), or a naphthalenyl, 5,6,7,8-tetrahydronaphthalenyl or biphenyl group;

$R^1$ ,  $R^2$  and  $R^3$  each independently represent a hydrogen or halogen atom, or a hydroxy group, or a phenyl,  $-OR^4$ ,  $-SR^4$ ,  $-NR^4R^5$ ,  $-NHCOR^4$ ,  $-CONR^4R^5$ ,  $-CN$ ,  $-NO_2$ ,  $-COOR^4$  or  $-CF_3$  group, or a straight or branched lower alkyl group which may optionally be substituted, for example, with a hydroxy or alkoxy group, wherein  $R^4$  and  $R^5$  each independently represent a hydrogen atom, straight or branched lower alkyl group, or together form an alicyclic ring; or  $R^1$  and  $R^2$  together form an aromatic, alicyclic or heterocyclic ring;

n is an integer from 0 to 4;

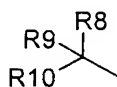
A represents a  $-\text{CH}_2-$ ,  $-\text{CH}=\text{CR}^6-$ ,  $-\text{CR}^6=\text{CH}-$ ,  $-\text{CR}^6\text{R}^7-$ ,  $-\text{CO}-$ ,  $-\text{O}-$ ,  $-\text{S}-$ ,  $-\text{S}(\text{O})-$ ,  $\text{SO}_2$  or  $-\text{NR}^6-$  group, wherein  $\text{R}^6$  and  $\text{R}^7$  each independently represent a hydrogen atom, straight or branched lower alkyl group, or  $\text{R}^6$  and  $\text{R}^7$  together form an alicyclic ring;

m is an integer from 0 to 8; provided that when  $m = 0$ , A is not  $-\text{CH}_2-$ ; p is an integer from 1 to 2 and the substitution in the azoniabicyclic ring may be in the 2, 3 or 4 position including all possible configurations of the asymmetric carbons;

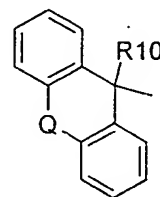
B represents a group of formula i) or ii):

10

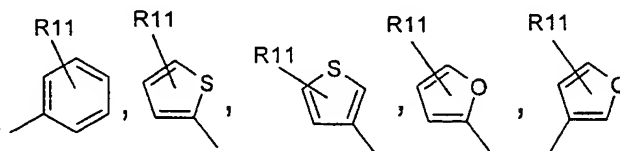
i)



ii)



wherein  $\text{R}^{10}$  represents a hydrogen atom, a hydroxy or methyl group; and  $\text{R}^8$  and  $\text{R}^9$  each independently represents



wherein  $\text{R}^{11}$  represents a hydrogen or halogen atom, or a straight or branched lower alkyl group and Q represents a single bond,  $-\text{CH}_2-$ ,  $-\text{CH}_2-\text{CH}_2-$ ,  $-\text{O}-$ ,  $-\text{O}-\text{CH}_2-$ ,  $-\text{S}-$ ,  $-\text{S}-\text{CH}_2-$  or  $-\text{CH}=\text{CH}-$ , and when i) or ii) contain a chiral centre they may represent either configuration;

X represents a pharmaceutically acceptable anion of a mono or polyvalent acid.

In the quaternary ammonium compounds of the present invention represented by formula (I) an equivalent of an anion ( $\text{X}^-$ ) is associated with the positive charge of the N atom.  $\text{X}^-$  may be an anion of various mineral acids such as, for example, chloride, bromide, iodide, sulfate, nitrate, phosphate, and organic acids such as, for example, acetate, maleate, fumarate, citrate, oxalate, succinate, tartrate, malate,

20

mandelate, methanesulfonate and p-toluenesulfonate.  $X^-$  is preferably an anion selected from chloride, bromide, iodide, sulphate, nitrate, acetate, maleate, oxalate or succinate. More preferably  $X^-$  is chloride, bromide or trifluoroacetate.

5       The compounds of the present invention represented by the formula (I) described above, which may have one or more assymmetric carbons, include all the possible stereoisomers. The single isomers and mixtures of the isomers fall within the scope of the present invention.

10       If any of  $R^1$  to  $R^7$  or  $R^{11}$  represents an alkyl group, it is preferred that said alkyl group contains 1 to 8, preferably 1 to 6 and more preferably 1 to 4 carbon atoms. In particular it is preferred that any alkyl group is represented by a methyl, ethyl, propyl, including i-propyl, butyl including a n-butyl, sec-butyl and tert-butyl.

15       The alicyclic and heterocyclic rings mentioned in relation to formula (I) preferably comprise from 3 to 10, preferably from 5 to 7 members. The aromatic rings mentioned in relation to formula (I) above preferably contain from 6 to 14, preferably 6 or 10 members.

20       Preferred compounds of formula (I) are those wherein © represents a phenyl, pyrrolyl, thienyl, furyl, biphenyl, naphthalenyl, 5, 6, 7, 8-tetrahydronaphthalenyl, benzo[1,3]dioxolyl, imidazolyl or benzothiazolyl group, in particular a phenyl, pyrrolyl, or thienyl group;  $R^1$ ,  $R^2$  and  $R^3$  each independently represent a hydrogen or halogen atom, or a hydroxyl, methyl, tert-butyl,  $-CH_2OH$ , 3-hydroxypropyl,  $-OMe$ ,  
25        $-NMe_2$ ,  $-NHCOMe$ ,  $-CONH_2$ ,  $-CN$ ,  $-NO_2$ ,  $-COOMe$  or  $-CF_3$  group, in particular a hydrogen atom, a hydroxy group or a halogen atom, wherein the halogen atom is preferably fluorine;  $n = 0$  or 1;  $m$  is an integer from 1 to 6, particularly 1, 2 or 3;  $A$  represents a  $-CH_2-$ ,  $-CH=CH-$ ,  $-CO-$ ,  $-NH-$ ,  $-NMe-$ ,  $-O-$  or  $-S-$  group, in particular a  $-CH_2-$ ,  $-CH=CH-$  or  $-O-$  group.

30       It is also preferred that  $p = 2$  and the substituent group  $-OC(O)B$  attached to the azoniabicyclo[2.2.2]octane is at the 3 position, preferably having the (R) configuration.

35       Further preferred compounds of formula I are those wherein  $B$  is a group of formula i) or ii) as defined above wherein, if  $B$  is a group of formula (i),  $R^8$  and  $R^9$  each independently represent a phenyl, 2-

thienyl, 3-thienyl, 2-furyl or 3-furyl group, wherein  $R^{11}$  is hydrogen atom; and, if B is a group of formula (ii), Q represents a single bond,  $-CH_2-$ ,  $-CH_2-CH_2-$ ,  $-O-$  or  $-S-$  group, in particular a single bond,  $-CH_2-$ ,  $-CH_2-CH_2-$  or  $-O-$  group, most preferably a single bond or  $-O-$  group ;  
 5 and in any case  $R^{10}$  is a hydrogen atom or a hydroxy or methyl group; and when i) or ii) contain a chiral centre they may represent either the (R) or the (S) configuration.

Most preferably the  $-OC(O)B$  group in formula (I) is diphenylacetoxy, 2-hydroxy-2,2-diphenyl-acetoxy,  
 10 2,2-diphenylpropionyloxy, 2-hydroxy-2-phenyl-2-thien-2-yl-acetoxy, 2-furan-2-yl-2-hydroxy-2-phenylacetoxy, 2,2-dithien-2-ylacetoxy, 2-hydroxy-2,2-di-thien-2-ylacetoxy, 2-hydroxy-2,2-di-thien-3-ylacetoxy, 9-hydroxy-9[H]-fluorene-9-carbonyloxy, 9-methyl-9[H]-fluorene-9-carbonyloxy, 9[H]-xanthene-9-carbonyloxy,  
 15 9-hydroxy-9[H]-xanthene-9-carbonyloxy, 9-methyl-9[H]-xanthene-9-carbonyloxy, 2,2-bis(4-fluorophenyl)-2-hydroxyacetoxy, 2-hydroxy-2,2-di-p-tolylacetoxy, 2,2-difuran-2-yl-2-hydroxy acetoxy, 2,2-dithien-2-ylpropionyloxy, 9,10-dihydroanthracene-9-carbonyloxy, 9[H]-thioxanthene-9-carbonyloxy, or 5[H]-dibenzo[a,d]cycloheptene-5-carbonyloxy. Especially preferred compounds are those wherein the  $-OC(O)B$  group in formula (I) is diphenylacetoxy, 2-hydroxy-2,2-diphenyl-acetoxy, 2,2-diphenylpropionyloxy, 2-hydroxy-2-phenyl-2-thien-2-yl-acetoxy,  
 25 2-furan-2-yl-2-hydroxy-2-phenylacetoxy, 2,2-dithien-2-ylacetoxy, 2-hydroxy-2,2-di-thien-2-ylacetoxy, 2-hydroxy-2,2-di-thien-3-ylacetoxy, 9-hydroxy-9[H]-fluorene-9-carbonyloxy, 9-methyl-9[H]-fluorene-9-carbonyloxy, 9[H]-xanthene-9-carbonyloxy, 9-hydroxy-9[H]-xanthene-9-carbonyloxy or 9-methyl-9[H]-xanthene-9-carbonyloxy.  
 30

The most preferred compounds of formula (I) are those wherein the azoniabicyclo group is substituted on the nitrogen atom with a 3-phenoxypropyl, 2-phenoxyethyl, 3-phenylallyl, phenethyl, 4-phenylbutyl, 3-phenylpropyl, 3-[2-hydroxyphenoxy]propyl, 3-[4-fluorophenoxy]propyl,  
 35 2-benzyloxyethyl, 3-pyrrol-1-ylpropyl, 2-thien-2-ylethyl, 3-thien-2-

ylpropyl, 3-phenylaminopropyl, 3-(methylphenylamino)propyl,  
 3-phenylsulfanylpropyl, 3-o-tolyloxypropyl,  
 3-(2,4,6-trimethylphenoxy)propyl,  
 3-(2-tert-butyl-6-methylphenoxy)propyl, 3-(biphenyl-4-yloxy)propyl,  
 5 3-(5,6,7,8-tetrahydronaphthalen-2-yloxy)-propyl, 3-(naphthalen-2-yloxy)  
 propyl, 3-(naphthalen-1-yloxy)propyl, 3-(2-chlorophenoxy)propyl,  
 3-(2,4-difluorophenoxy)propyl, 3-(3-trifluoromethyl phenoxy)propyl,  
 3-(3-cyanophenoxy)propyl, 3-(4-cyanophenoxy)propyl,  
 3-(3-methoxyphenoxy)propyl, 3-(4-methoxyphenoxy)propyl,  
 10 3-(benzo[1,3]dioxol-5-yloxy)propyl, 3-(2-carbamoylphenoxy)propyl,  
 3-(3-dimethylaminophenoxy)propyl, 3-(4-nitrophenoxy)propyl,  
 3-(3-nitrophenoxy)propyl, 3-(4-acetylaminophenoxy)propyl,  
 3-(3-methoxycarbonylphenoxy)propyl, 3-[4-(3-hydroxypropyl)  
 phenoxy]propyl, 3-(2-hydroxymethylphenoxy)propyl,  
 15 3-(3-hydroxymethylphenoxy)propyl, 3-(4-hydroxymethylphenoxy)propyl,  
 3-(2-hydroxyphenoxy)propyl, 3-(4-hydroxyphenoxy)propyl,  
 3-(3-hydroxyphenoxy)propyl, 4-oxo-4-thien-2-ylbutyl, 3-(1-methyl-[1H]-  
 imidazol-2-ylsulfanyl)propyl, 3-(benzothiazol-2-yloxy)propyl,  
 3-benzyloxypropyl, 6-(4-phenylbutoxy)hexyl, 4-phenoxybutyl, or  
 20 2-benzyloxyethyl group. Especially preferred compounds are those  
 wherein the azoniabicyclo group is substituted on the nitrogen atom  
 with a 3-phenoxypropyl, 2-phenoxyethyl, 3-phenylallyl, phenethyl, 4-  
 phenylbutyl, 3-phenylpropyl, 3-[2-hydroxyphenoxy]propyl, 3-[4-  
 fluorophenoxy]propyl, 2-benzyloxyethyl, 3-pyrrol-1-ylpropyl, 2-thien-2-  
 25 ylethyl or 3-thien-2-ylpropyl group.

The following compounds are intended to illustrate but not to limit the scope of the present invention.

3(R)-Diphenylacetoxyl-1-(3-phenoxy-propyl)-1-azoniabicyclo[2.2.2]octane;  
bromide

30 3(R)-(2-Hydroxy-2,2-diphenyl-acetoxyl)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

3(R)-(2,2-Diphenylpropionyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

35 3(R)-(2-Hydroxy-2-phenyl-2-thien-2-yl-acetoxyl)-1-(3-phenoxypropyl)-1-azonia-bicyclo[2.2.2]octane; bromide

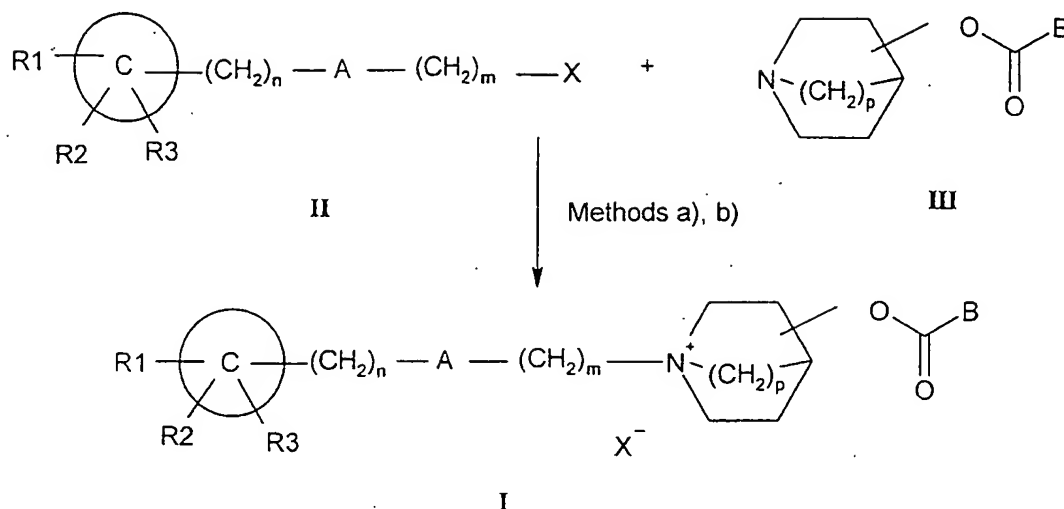


- 3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-(3-phenylallyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 5 3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2,2-Dithien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Hydroxy-2,2-di-thien-2-ylacetoxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide
- 10 3(R)-(2-Hydroxy-2,2-di-thien-2-ylacetoxy)-1-(4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 15 1-[3-(4-Fluorophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2]octane; chloride
- 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(2-hydroxyphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate
- 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-pyrrol-1-ylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate
- 20 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(2-thien-2-ylethyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 25 1-(2-Benzyloxyethyl)-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate
- 3(R)-(2-Hydroxy-2,2-dithien-3-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 1-(3-phenylallyl)-3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide
- 30 3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide
- 35 3(R)-(9-Hydroxy-9H-fluorene-9-carbonyloxy)-1-(3-thien-2-ylpropyl)-1-

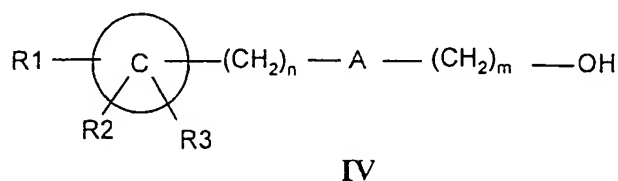
- azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(3-phenylallyl)-1-azonia  
bicyclo[2.2.2]octane; bromide
- 3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azo  
5 niabicyclo[2.2.2]octane; bromide
- 1-(4-Phenylbutyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo  
[2.2.2]octane; bromide
- 1-(2-Phenoxyethyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo  
[2.2.2]octane; bromide
- 10 1-(3-Phenoxypropyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo  
[2.2.2]octane; bromide
- 1-Phenethyl-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]  
octane; bromide
- 3(R)-(9-Hydroxy-9[H]-xanthene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-  
15 azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(9-Hydroxy-9[H]-xanthene-9-carbonyloxy)-1-phenethyl-1-azoniabicy  
clo[2.2.2]octane; bromide
- 3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(3-thien-2-ylpropyl)-1-  
azoniabicyclo[2.2.2]octane; bromide
- 20 3(R)-(9-Methyl-9[H]-xanthene-9-carbonyloxy)-1-(3-phenoxy-propyl)-1-a  
zonias-bicyclo[2.2.2]octane; bromide

The present invention also provides processes for preparing compounds of formula (I).

- 25 The quaternary ammonium derivatives of general Formula I, may be prepared by reaction of an alkylating agent of general Formula II with compounds of general Formula III. In Formulas I, II and III, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, C, A, X, B, n, m and p are as defined above.

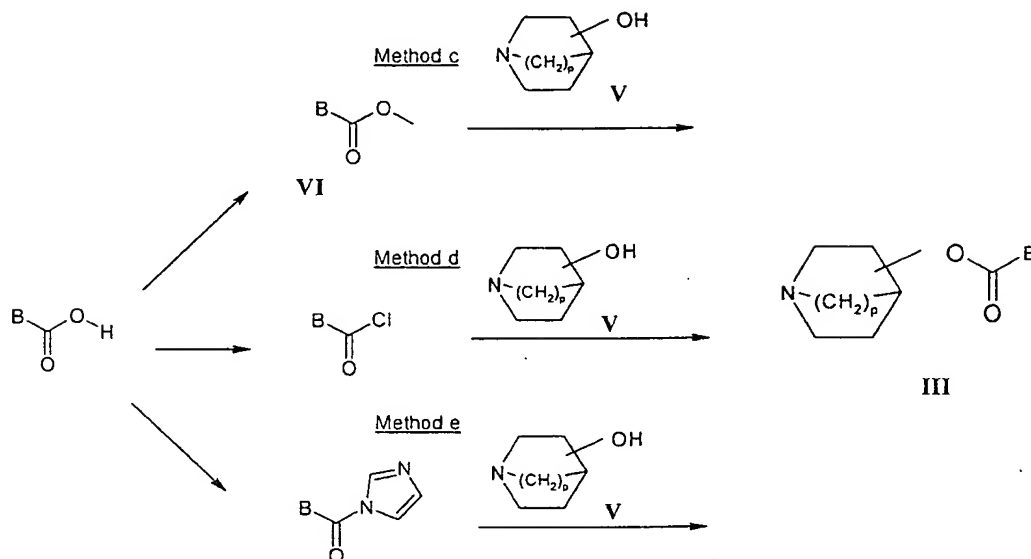


This alkylation reaction may be carried out by two different experimental procedures, a) and b) which are described below. In particular method b) provides a new experimental process, using solid phase extraction methodologies, that allows the parallel preparation of several compounds. Methods a) and b) are described in the experimental section. Compounds of general Formula II which are not commercially available have been prepared by synthesis according to standard methods. For example, compounds wherein  $n = 0$  and  $A = -O-$ ,  $-S-$  or  $-NR^6$ , wherein  $R^6$  is as defined above, were obtained by reaction of the corresponding aromatic derivative or its potassium salt with an alkylating agent of general formula  $Y-(CH_2)_m-X$ , wherein X may be a halogen and Y may be a halogen or a sulphonate ester. In other examples, compounds of general Formula II, where  $n \geq 1$  were synthesised from the corresponding alcohol derivative of general Formula IV by known methods.

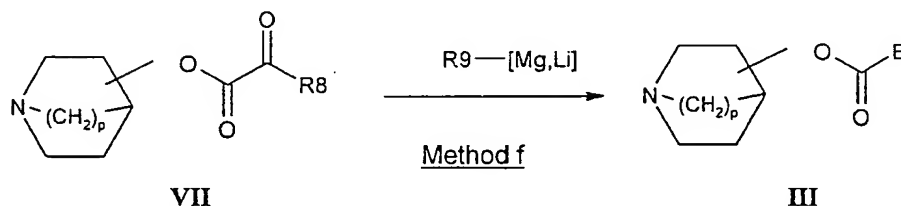


Compounds of general Formula III may be prepared by three

different methods c,d and e illustrated in the following scheme and detailed in the experimental section.



Some compounds of general formula III where B is a group of formula i),  $R^8$  and  $R^9$  are as described above and  $R^{10}$  is a hydroxy group, may also be prepared from the glyoxalate esters of general formula VII by reaction with the corresponding organometallic derivative.



Compounds of general formula VII may be prepared from the corresponding glyoxylic acids following the standard methods c, d and e described above and detailed in the experimental section. The glyoxalate derivatives of formula VII where  $R^8$  is a 2-thienyl or 2-furyl group have not been described before.

The following compounds are examples of compounds of general formula III and VII which have not been described before:  
 9-Methyl-9[H]-fluorene-9-carboxylic acid 1-azabicyclo[2.2.2]oct-3(R)

- yl ester (intermediate I-1c);  
9-Methyl-9[H]-xanthene-9-carboxylic acid 1-azabicyclo[2.2.2]oct-3(R)  
-yl ester (intermediate I-1d);  
2-Hydroxydithien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-4-yl ester  
5 (intermediate I-4a).  
Oxothien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-4-yl ester  
(intermediate I-4b).  
Oxothien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester  
(intermediate I-4g).  
10 Oxofuran-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester  
(intermediate I-4e).  
2-Hydroxy-2,2-difuran-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-3(R)  
-yl ester (intermediate I-4d).

Compounds of Formula V could be:

- 15 4-hydroxy-1-azabicyclo[2.2.1]heptane, described in WO150080  
4-hydroxy-1-azabicyclo[2.2.2]octane, described in Grob, C.A. et.al.  
Helv.Chim.Acta (1958), 41, 1184-1190  
3(R)-hydroxy-1-azabicyclo[2.2.2]octane or 3(S)-hydroxy-1-  
azabicyclo[2.2.2]octane, described in Ringdahl, R. Acta Pharm Suec.  
20 (1979), 16, 281-283 and commercially available from CU Chemie  
Uetikon GmbH.

The following examples are intended to illustrate, but not to  
limit, the experimental procedures that have been described above.

- 25 The structures of the prepared compounds were confirmed by <sup>1</sup>H-  
NMR and MS. The NMR were recorded using a Varian 300 MHz instrument  
and chemical shifts are expressed as parts per million (δ) from the  
internal reference tetramethyl silane. Their purity was determined by  
HPLC, using reverse phase chromatography on a Waters instrument, with  
values greater than 95% being obtained. Molecular ions were obtained  
30 by electrospray ionization mass spectrometry on a Hewlett Packard  
instrument.

#### Method - a -

- 35 Example : 20- Preparation of 3(R)-(2-Furan-2-yl-2-hydroxy-2-phenyl

acetoxyl)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane, bromide. 200 mg of (Furan-2-yl)-hydroxy-phenylacetic acid 1-aza-bicyclo[2.2.2]oct-3(R)-yl ester (0.6 mmol) were suspended in 4 ml of CH<sub>3</sub>CN and 6 ml of CHCl<sub>3</sub>. To this suspension were added 0.48 ml (3 mmol) of 3-phenoxypropyl bromide. After stirring for 72 h at room temperature in inert atmosphere, solvents were evaporated. Ether was added and the mixture stirred. The solid obtained was filtered and washed several times with ether. The yield was 0.27 g (83%) of title compound as a mixture of diastereomers.

<sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.50-2.20 (m, 6H), 2.25 (m, 1H), 3.10 (m, 1H), 3.20-3.60 (m, 6H), 3.95 (m, 1H), 4.05 (m, 2H), 5.20 (m, 1H), 6.25-6.35 (double dd, 1H), 6.45 (m, 1H), 6.95 (m, 4H), 7.30-7.50 (m, 7H), 7.70 (m, 1H); MS [M-Br]<sup>+</sup>: 462; mp 166 °C.

#### 15 Method - b -

**Example 51 - Preparation of 3(R)-(2-Hydroxy-2,2-di-thien-2-yl acetoxyl)-1-[3-(naphthalen-1-yloxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

20 60 mg (0.17 mmols) of hydroxy-dithien-2-yl-acetic acid 1-aza-bicyclo[2.2.2]oct-3(R)-yl ester were dissolved in 1ml of dmsol. To this solution 188 mg (0.85 mmol) of 3-(naphthalen-1-yloxy)-propyl chloride were added. After stirring overnight at room temperature, the mixture was purified by solid phase extraction with a cation exchange  
25 Mega Bond Elut cartridge, previously conditioned at pH = 7.5 with 0.1 M NaH<sub>2</sub>PO<sub>4</sub> buffer. The reaction mixture was applied to the cartridge and washed first with 2 ml of DMSO and then three times with 5 ml of CH<sub>3</sub>CN, rinsing away all starting materials. The ammonium derivative was eluted with 5 ml of 0.03 M TFA solution in CH<sub>3</sub>CN:CHCl<sub>3</sub> (2:1). This  
30 solution was neutralized with 300 mg of poly(4-vinylpyridine), filtered and evaporated to dryness.

The yield was 17 mg (15%) of title compound. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 - 2.1 (m, 4H), 2.2 - 2.4 (m, 3H), 3.2 - 3.6 (m, 7H), 4.0 (m, 1H), 4.2 (t, 2H), 5.25 (m, 1H), 7.0 (m 3H), 7.2 (m, 2H), 7.4 - 7.6 (m, 7H), 7.85 (d, 1H), 8.2 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 534.

## Method - c -

Methyl ester derivatives of general Formula VI were prepared by standard methods of esterification from the corresponding carboxylic acid or following the procedures described in examples I-le, I-lf and I-lg or according to procedures described in literature: FR 2012964; Larsson, L et al. Acta Pharm. Suec. (1974), 11(3), 304-308; Nyberg, K. et.al. Acta Chem.Scand. (1970), 24, 1590-1596; and Cohen, V.I. et.al. J.Pharm.Sciences (1992), 81, 326-329.

**Example I-1a- Preparation of (Furan-2-yl)hydroxyphenylacetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.**

3.24 g (0.014 mols) of (Furan-2-yl)-hydroxy-phenylacetic acid methyl ester were dissolved in 85 ml of toluene. To this solution were added 2.08 g (0.016 mols) of 3-(R)-hydroxy-1-azabicyclo[2.2.2]octane and 0.224 g (5.6 mmols) of HNa (60% dispersion in mineral oil). The mixture was refluxed with continuous removal of distillate and when necessary replacement with fresh toluene for 1.5 hours. The cooled mixture was extracted with 2N HCl acid, the aqueous layer washed with ethyl acetate, basified with K<sub>2</sub>CO<sub>3</sub> and extracted with CHCl<sub>3</sub>. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated. The oil obtained (3.47 g) crystallised after cooling at room temperature. This solid was suspended in hexane and filtered. The yield was 2.5 g (54%) of a mixture of diastereoisomers, mp: 140-142 °C; GC/MS [M]<sup>+</sup>: 327;

<sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.20-1.70 (m, 4H), 1.90-2.10 (m, 1H), 2.45-2.80 (m, 5H), 3.10-3.30 (m, 1H), 4.8 (bs, OH), 4.90-5.0 (m, 1H), 6.20 (m, 1H), 6.35 (m, 1H), 7.30-7.50 (m, 4H), 7.60-7.70 (m, 2H).

After four crystallizations of 0.5 g of this mixture from boiling acetonitrile, 0.110 g of a pure diastereomer(1) were obtained.

From the mother liquors of crystallization was obtained the other diastereomer (2). (\*:configuration not assigned). Diastereomer 1 was hydrolysed to yield (+)-2-hydroxy-2-phenyl-2-furan-2-ylacetic acid as a pure enantiomer, [α]<sup>25</sup><sub>D</sub> = +5.6 (c=2, EtOH). Diastereomer 2 was hydrolysed to yield (-)-2-hydroxy-2-phenyl-2-furan-2-ylacetic acid as a pure enantiomer, [α]<sup>25</sup><sub>D</sub> = -5.7 (c=2, EtOH).

Diastereomer 1: 2(\*)-(Furan-2-yl)hydroxyphenylacetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.20-1.70 (m, 4H), 1.90 (m, 1H), 2.45-2.50 (m, 1H), 2.50-2.80 (m, 4H), 3.10-3.20 (m, 1H), 4.8 (bs, OH), 4.90-5.0 (m, 1H), 6.20 (m, 1H), 6.35 (m, 1H), 7.30-7.50 (m, 4H), 7.60-7.70 (m, 2H).

Diastereomer 2: 2(\*)-(Furan-2-yl)hydroxyphenylacetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.20-1.70 (m, 4H), 2.10 (m, 1H), 2.50-2.80 (m, 5H), 3.20-3.30 (m, 1H), 4.8 (bs, OH), 4.90-5.0 (m, 1H), 6.20 (m, 1H), 6.35 (m, 1H), 7.30-7.50 (m, 4H), 7.60-7.70 (m, 2H).

**Example I-1b- Preparation of Furan-2-ylhydroxythien-2-ylacetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.**

Prepared as in example I-1 a. The yield was 3.06 g (64.3 %) of a mixture of diastereoisomers, mp: 172°C; GC/MS [M]<sup>+</sup>: 333;

<sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.21-1.27 (m, 1H), 1.41-1.60 (m, 3H), 1.87 (m, 1H), 2.36-2.69 (m, 5H), 3.02-3.14 (m, 1H), 4.75-4.82 (m, 1H), 6.24-6.25 (m, 1H), 6.42-6.45 (m, 1H), 7.01-7.06 (m, 1H), 7.11-7.14 (m, 2H), 7.51-7.54 (m, 1H), 7.66-7.69 (m, 1H).

**Example I-1c- Preparation of 9-Methyl-9[H]-fluorene-9-carboxylic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.**

Prepared as in example I- 1 a. The yield was 3.34 g of an oil (80 %). This product was solidified by formation of the oxalate salt (1:1), mp: 186°C. MS [M free base + 1]<sup>+</sup>: 334.

Oxalate salt, <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.43-1.55 (m, 2H), 1.68-1.78 (m, 2H), 1.75 (s, 3H), 2.02 (m, 1H), 2.70-2.90 (m, 1H), 2.92-3.15 (m, 4H), 3.50-3.57 (m, 1H), 4.88 (m, 1H), 7.35-7.47 (m, 4H), 7.62-7.70 (m, 2H), 7.89-7.91 (m, 2H).

**Example I-1d- Preparation of 9-Methyl-9[H]-xanthene-9-carboxylic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.**

Prepared as in example I- 1 a. The yield was 1.91 g of an oil (53%). This product was solidified by formation of the oxalate salt (1:1), mp: 152°C. MS [M free base + 1]<sup>+</sup>: 350.



Oxalate salt,  $^1\text{H}$ - NMR (DMSO- $d_6$ ):  $\delta$  1.20-1.30 (m, 1H), 1.40-1.52 (m, 1H), 1.64-1.81 (m, 2H), 1.90 (s, 3H), 2.0 (m, 1H), 2.53-2.66 (m, 1H), 2.71-2.76 (m, 1H), 2.97-3.10 (m, 3H), 3.44-3.52 (m, 1H), 4.90-4.92 (m, 1H), 7.12-7.18 (m, 4H), 7.32-7.38 (m, 2H), 7.43-7.48 (m, 2H), 8.0-9.8 (bs, 1H,  $\text{H}^+$ ).

**Example I-1e-Preparation of 9-Methyl-9[H]-fluorene-9-carboxylic acid methyl ester.**

Lithium diisopropylamide (26.7 ml of a 2M solution in heptane/tetrahydrofuran/ethylbenzene, 0.053 mol) was added to a stirred solution of 9[H]-fluorene-9-carboxylic acid (5 g, 0.0237 mol) in THF (70 ml) at between 0 and 5°C in  $\text{N}_2$  atmosphere. The mixture was warmed to room temperature and refluxed 1.5 hours. The reaction mixture was cooled to room temperature and a solution of  $\text{CH}_3\text{I}$  (1.85 ml, 0.03 mol) in THF (1.85 ml) was added. The mixture was stirred overnight at room temperature and evaporated. To the residue in MeOH (70 ml) was added concentrated sulfuric acid (3.9 ml) in MeOH (25 ml), the mixture was refluxed for 2 hours and evaporated. The residue was partitioned between chloroform and saturated  $\text{K}_2\text{CO}_3$  solution. The aqueous layer was extracted again with chloroform and the organic layers were combined, washed with water, dried over sodium sulphate and evaporated to dryness to obtain 5.73 g of a brown oil. This product was purified by column chromatography (silica gel, hexane/ethyl acetate 95:5) to yield 4.43 g (78.5%) of a pure product, structure confirmed by  $^1\text{H}$ -NMR.

$^1\text{H}$ - NMR ( $\text{CDCl}_3$ ):  $\delta$  1.80 (s, 3H), 3.60 (s, 3H), 7.50-7.65 (m, 4H), 7.75 (m, 2H), 8.0 (m, 2H).

**Example I-1f -Preparation of 9-Methyl-9[H]-xanthene-9-carboxylic acid methyl ester.**

Prepared as in example I-1e. The yield was 2.65 g (47.2%).  $^1\text{H}$ - NMR ( $\text{CDCl}_3$ ):  $\delta$  1.90 (s, 3H), 3.6 (s, 3H), 7.05-7.35 (m, 8H).

**Example I-1g- Preparation of 9-Hydroxy-9[H]-xanthene-9-carboxylic acid methyl ester.**

Lithium diisopropylamide (20.3 ml of a 2M solution in

heptane/tetrahydrofuran/ethylbenzene, 0.041 mol) was added to a stirred solution of 7 g (0.029 mol) of 9[H]-xantene-9-carboxylic acid methyl ester (prepared by a standard method) in THF (70 ml) at between 0 and 5°C in N<sub>2</sub> atmosphere. The mixture was stirred 1 h at this temperature and then was added by N<sub>2</sub> pressure to a dry solution of oxygen in ether, at 0°C. After 30 min, an equal volume of NaHSO<sub>3</sub>, 40% aqueous solution, was added, and the reaction mixture was warmed to room temperature and stirred for 30 min. The two layers were separated and the aqueous phase was extracted twice with ethyl acetate. The organic phases were combined, treated with NaHSO<sub>3</sub> (40% aqueous solution), washed with water, dried over sodium sulphate and evaporated to dryness to obtain 8.89 g of a brown solid.

This procedure was repeated with 5 g of starting material yielding 6.04g of the same brown solid.

The products were combined and purified by column chromatography (silica gel, hexane/ethyl acetate 90:10) to yield 7.60g (global Rt: 59.4%) of a pure product, structure confirmed by <sup>1</sup>H-NMR.

<sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 3.5 (s, 3H), 7.0 (s, 1H, OH), 7.2 (m, 4H), 7.4 (m, 2H), 7.55 (m, 2H).

20

#### Method - d -

**Example I-2a- Preparation of 10,11-Dihydro-5[H]-dibenzo[a,d]cycloheptane-5-carboxylic acid 1-azabicyclo[2.2.2]oct-3-(R)-yl ester.**

2.15g of 10,11-Dihydro-5[H]-dibenzo[a,d]cycloheptane-5-carboxylic acid (9.0 mmol) were dissolved in 40 ml of CHCl<sub>3</sub> (ethanol free). The solution was cooled at 0 °C and 0.86 ml of oxalyl chloride (9.9 mmols) and a drop of DMF were added. The mixture was stirred and allowed warm to room temperature. After an hour at this temperature the solvents were evaporated and the residue was dissolved in CHCl<sub>3</sub> and evaporated again. This procedure was repeated two times. The obtained oil was dissolved in 20 ml of toluene and added to a solution of 1.26 g (9.9 mmol) of 3-(R)-hydroxy-1-azabicyclo[2.2.2]octane in 40 ml of hot toluene. The reaction mixture was refluxed for 2 hours. After cooling the mixture was extracted with 2N HCl acid. The aqueous layer was

35

basified with K<sub>2</sub>CO<sub>3</sub> and extracted with CHCl<sub>3</sub>. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness. The residue was purified by column chromatography (silica gel, CHCl<sub>3</sub>:MeOH:NH<sub>4</sub>OH, 95:5:0.5). The yield was 1.5 g (48 %); mp: 112-113 °C; CG/MS [M]<sup>+</sup>: 347; <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.10-1.35 (m, 2H), 1.40-1.52 (m, 1H), 1.52-1.68 (m, 1H), 1.90 (m, 1H), 2.40-2.60 (m, 2H), 2.60-2.77 (m, 3H), 2.83-2.96 (m, 2H), 3.07-3.19 (m, 1H), 3.25-3.40 (m, 2H), 4.80 (m, 2H), 7.10-7.30 (m, 8H). 10,11-Dihydro-5[H]-dibenzo[a,d]cycloheptane-5-carboxylic acid was prepared as described in Kumazawa T. et al., J. Med. Chem., (1994), 37, 804-810.

**Example I-2b- Preparation of 5[H]-Dibenzo[a,d]cycloheptene-5-carboxylic acid 1-azabicyclo[2.2.2]oct-3-(R)-yl ester.**

Prepared as in example I-2a. The yield was 3.12 g (71%); mp 129°C; MS [M+1]<sup>+</sup>: 346; <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 0.90-1.10 (m, 2H), 1.30-1.50 (m, 2H), 1.58 (m, 1H), 2.21-2.26 (m, 2H), 2.47-2.50 (m, 3H), 2.86-2.94 (m, 1H), 4.48-4.51 (m, 1H), 5.33 (s, 1H), 7.0 (m, 2H), 7.29-7.43 (m, 6H), 7.49-7.51 (m, 2H).

5[H]-Dibenzo[a,d]cycloheptene-5-carboxylic acid was prepared as described in M.A. Davis et al; J. Med. Chem., (1964), Vol 7, 88-94.

**Example I-2c-Preparation of 9,10-Dihydroanthracene-9-carboxylic acid 1-azabicyclo[2.2.2]oct-3-(R)-yl ester**

Prepared as in example I-2a. The yield was 0.77 g (62.6%); mp 139°C; MS [M+1]<sup>+</sup>: 334; <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.1-1.2 (m, 1H), 1.25-1.40 (m, 2H), 1.40-1.55 (m, 1H), 1.73 (m, 1H), 2.20 (m, 1H), 2.35-2.65 (m, 4H), 2.90-2.98 (m, 1H), 3.93-4.14 (dd, 2H, J = 1.8 Hz, J = 4.3 Hz), 4.56 (m, 1H), 5.14 (s, 1H), 7.25-7.35 (m, 4H), 7.35-7.50 (m, 4H).

9,10-Dihydro-anthracene-9-carboxylic acid was prepared as described in E. L. May and E. Mossettig; J. Am. Chem. Soc., (1948), Vol 70, 1077-9.

Method - e -

**Example I-3. Preparation of 2,2-Diphenylpropionic acid 1-azabicyclo**

**[2.2.2]oct-3(R)-yl ester.**

1.1 g (4.8 mmol) of 2,2-diphenylpropionic acid were dissolved in 20 ml of THF. To this solution were added 0.87 g (5.3 mmol) of 1,1'-carbonyldiimidazole and the mixture was refluxed for an hour. The reaction was monitored by TLC following the formation of the imidazolide. When the reaction was completed part of the solvent was evaporated and 0.67 g (5.3 mmol) of 3-(R)-hydroxy-1-azabicyclo[2.2.2]octane were added. The reaction mixture was refluxed for 16 h, cooled, diluted with ether and washed with water. The organic layer was extracted with HCl 2N, the acid solution basified with K<sub>2</sub>CO<sub>3</sub> and extracted with CHCl<sub>3</sub>. The organic solution was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness to yield 1.21 g (75.2%) of an oil that was identified as the title ester.

0.64 g (1.9 mmol) of 2,2-Diphenylpropionic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester were dissolved in 6 ml of ketone and 0.085 g (0.95 mmol) of oxalic acid were added. After slow addition of ether a white solid was formed. The yield was 0.33g (45.6%) of oxalate of 2,2-Diphenyl-propionic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester; mp: 146°C; MS [M free base+1]<sup>+</sup>: 336.

Oxalate salt, <sup>1</sup>H-NMR (CDCl<sub>3</sub>): δ 1.40-1.64 (m, 2H), 1.90 (s, 3H), 1.80-2.0 (m, 2H), 2.31 (m, 1H), 2.73-2.85 (m, 1H), 3.0-3.10 (m, 1H), 3.10-3.32 (m, 3H), 3.53-3.70 (m, 1H), 5.13 (m, 1H), 7.14-7.40 (m, 10H), 9.25 (broad band, 2H, H<sup>+</sup>).

**Method -f-****Example I-4a- Preparation of 2-Hydroxy-2,2-dithien-2-ylacetic acid 1-azabicyclo[2.2.2]oct-4-yl ester.**

A solution of 2-thienylmagnesium bromide was prepared from 220 mg (9 mmols) of Magnesium and 0.86 ml (9 mmols) of 2-bromothiophene in 15 ml of THF. This solution was added to 1.95 g (7mmols) of oxothien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-4-yl ester (intermediate I-4b) dissolved in 20 ml of THF. The mixture was stirred at room temperature for 1 hour, refluxed for 1 hour, cooled, treated with a saturated solution of ammonium chloride and extracted with ether. After removal

of the solvent the solid obtained was recrystallised from acetonitrile to yield 1.45 g, of a white solid (56%). <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.80-2.0 (m, 6H), 2.80-3.0 (m, 6H), 7.0 (m, 2H), 7.13 (m, 2H), 7.18 (s, 1H), 7.51 (m, 2H); MS [M+1]: 350; mp 174°C.

5

**Example I-4b- Preparation of oxothien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-4-yl ester.**

Oxalyl chloride (1.5ml, 0.017 mol) was added to a solution of oxothien-2-yl-acetic acid (2.24 g, 0.014 mol) and dimethylformamide (one drop) in 30 ml of chloroform (etanol free) at 0°C. The mixture was stirred and allowed to warm at room temperature. After one hour the solvent was evaporated. The residue was dissolved in chloroform and evaporated again. This procedure was repeated two times. The product obtained was dissolved in CHCl<sub>3</sub> (30 ml) and added to a suspension of 1.1g (0.009mols) of 4-hydroxy-1-azabicyclo[2.2.2]octane, 1.8ml of triethylamine (0.013mols), 0.6g (0.9mmols) of N-(methylpolystyrene)-4-(methylamino) pyridine at 70°C. The mixture was refluxed for 1 hour, cooled, filtered and washed with water. The title product was extracted with a solution of diluted HCl, washed with CHCl<sub>3</sub>, basified with K<sub>2</sub>CO<sub>3</sub> and extracted again with CHCl<sub>3</sub>. After removal of the solvent 1.47g (45%) of a solid was obtained. <sup>1</sup>H- NMR (dmsO): δ 2.0 (m, 6H), 2.9 (m, 6H), 7.35 (m, 1H), 8.05 (m, 1H), 8.3 (m, 1H).

**Example I-4c- Preparation of (Furan-2-yl)hydroxyphenylacetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.**

Phenylmagnesium bromide ,0.0057 mol (5.7 ml of a solution 1M in THF), was added to a solution of 1.3 g ( 0.0052 mol) of oxofuran-2-ylacetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester (intermediate I-4e-) dissolved in 15 ml of THF, at -70°C in N<sub>2</sub> atmosphere. The mixture was stirred at this temperature for 10 minuts, and then warmed to room temperature . After 1 hour , the reaction mixture was treated with a saturated solution of ammonium chloride and extracted three times with ethyl acetate . The organic phases were combined, washed with water and dried over Na<sub>2</sub>SO<sub>4</sub>. After removal of the solvent, the solid obtained was treated with ether and filtered to yield 0.67 g (40 %) of

a product whose structure was confirmed by  $^1\text{H}$ -NMR. This compound was also prepared as is described in Example I-1a (Method c). The diastereomers were separated by crystallization from acetonitrile and distinguished by  $^1\text{H}$ -NMR.

5

**Example I-4d- Preparation of 2-Hydroxy-2,2-difur-2-yl-acetic acid 1-azabicyclo [2.2.2]oct-3(R)-yl ester.**

The title compound was synthesised as in example I-4c from intermediate I-4e- and 2-furanyl lithium which was prepared with furane and butyl lithium following a standard method. The yield was 380 mg (8%).  $^1\text{H}$ - NMR (CDCl<sub>3</sub>):  $\delta$  1.2-1.4 (m, 1H), 1.4-1.8 (m, 3H), 2.0 (m, 1H), 2.6-2.85 (m, 5H), 3.2 (m, 1H), 5.0 (m, 1H), 6.4 (m, 3H), 7.3 (m, 1H), 7.5 (m, 2H). MS [M+1]<sup>+</sup>: 318.

15 **Example I-4e- Preparation of oxofuran-2-yl-acetic acid 1-azabicyclo [2.2.2]oct-3(R)-yl ester.**

Oxalyl chloride (9.75 ml, 0.112 mol) was added to a solution of oxofuran-2-ylacetic acid (10 g, 0.071 mol) and dimethylformamide (one drop) in 150 ml of chloroform (etanol free) at 0°C. The mixture was stirred and allowed to warm at room temperature. After five hours the solvent was evaporated. The residue was dissolved in chloroform and evaporated again. This procedure was repeated two times. The product obtained was dissolved in CHCl<sub>3</sub> (150 ml) and a solution of 3(R)-quinuclidinol (10.90 g, 0.086 mol) in CHCl<sub>3</sub> (150 ml) was added to this at 0°C. The mixture was stirred and allowed to warm at room temperature. After 15 h at r.t., the mixture was washed with 10% aqueous potassium carbonate, then with water, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give 9.34 g (52.5%) of the title compound as a dark oil. Estructure confirmed by NMR.

30  $^1\text{H}$ - NMR (CDCl<sub>3</sub>):  $\delta$  1.40-1.60 (m, 1H) , 1.60-1.80 (m, 2H), 1.80-2.05 (m, 1H), 2.20 (m, 1H), 2.70-3.10 (m, 5H), 3.30-3.45 (m, 1H), 5.10 (m, 1H), 6.7 (m, 1H), 7.7 (m, 1H), 7.8 (m, 1H).

35 **Example I-4f- Preparation of 2-Hydroxy-2-phenyl-2-thien-2-ylacetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.**

The title compound was prepared as described in example I-4c from intermediate I-4g. The yield was 3 g (33%) as a mixture of diastereomers. After five crystallizations of 1.5 g of this mixture from boiling isopropanol, 0.200 g of a pure diastereomer(1) were  
5 obtained. The mother liquors from first crystallization were enriched with the other diastereomer (2). Diastereomer 1 was hydrolysed to yield (+)-2-Hydroxy-2-phenyl-2-thien-2-ylacetic acid as a pure enantiomer,  $[\alpha]^{25}_D = +25.4$  (c=2, EtOH). This value was assigned to the R configuration provided that in literature (A.I.Meyers et.al.  
10 J.Org.Chem. (1980), 45(14), 2913) the 2(S) enantiomer has been described with  $[\alpha]^{25}_D = -20$  (c=2, EtOH).

**Diastereomer 1: 2(R)-2-Hydroxy-2-phenyl-2-thien-2-ylacetic acid 1-aza bicyclo[2.2.2]oct-3(R)-yl ester.**  $^1\text{H-NMR}$  (DMSO- $d_6$ ):  $\delta$  1.1-1.25 (m, 1H), 1.3-1.6 (m, 3H), 1.83 (m, 1H), 2.4-2.7 (m, 5H), 3.1 (m, 1H), 4.8 (m,  
15 1H), 7.0 (m, 2H), 7.05 (m, 1H), 7.3-7.4 (m, 3H), 7.4-7.45 (m, 2H), 7.5 (m, 1H).

**Diastereomer 2: 2(S)-2-Hydroxy-2-phenyl-2-thien-2-ylacetic acid 1-aza bicyclo[2.2.2]oct-3(R)-yl ester.**  $^1\text{H-NMR}$  (DMSO- $d_6$ ):  $\delta$  1.1-1.25 (m, 1H), 1.4-1.6 (m, 3H), 1.9 (m, 1H), 2.3-2.7 (m, 5H), 3.05 (m, 1H), 4.8 (m,  
20 1H), 7.0 (m, 2H), 7.05 (m, 1H), 7.3-7.4 (m, 3H), 7.4-7.45 (m, 2H), 7.5 (m, 1H).

**Example I-4g- Preparation of oxothien-2-yl-acetic acid 1-azabicyclo [2.2.2]oct-3(R)-yl ester.**

25 Oxalyl chloride (1.34 ml, 0.0154 mol) was added to a solution of oxothien-2-yl-acetic acid (2 g, 0.0128 mol) and dimethylformamide (one drop) in 30 ml of chloroform (etanol free) at 0°C. The mixture was stirred and allowed to warm at room temperature. After one hour the solvent was evaporated. The residue was dissolved in chloroform and  
30 evaporated again. This procedure was repeated two times. The product obtained was dissolved in  $\text{CHCl}_3$  (30 ml) and a solution of 3(R)-quinuclidinol (1.95g, 0.0154 mol) in  $\text{CHCl}_3$  (30 ml) was added to this at 0°C. The mixture was stirred and allowed to warm at room temperature. After 1.5 h at r.t., the mixture was washed with 10%  
35 aqueous potassium carbonate, then with water, dried over  $\text{Na}_2\text{SO}_4$  and

evaporated to give 3.14 g (92.6%) of the title compound as a yellow oil. <sup>1</sup>H-NMR (CDCl<sub>3</sub>): δ 1.40-1.50 (m, 1H), 1.50-1.70 (m, 1H), 1.70-1.80 (m, 1H), 1.90-2.0 (m, 1H), 2.15 (m, 1H), 2.70-3.05 (m, 5H), 3.30-3.40 (m, 1H), 5.05 (m, 1H), 7.20 (m, 1H), 7.85 (m, 1H), 8.10 (m, 1H).

5

Other carboxylic acids of Formula B-C(O)OH, whose preparation (or the syntheses of their derivatives methyl ester, chloride or imidazolide) haven't been described in methods c,d,e or in the Examples I-le, I-lf and I-lg, and that are not commercially available, could be prepared as is described in the following references:

10

FR 2012964

M.A. Davis et al; J. Med. Chem. (1963), 6, 513-516.

T. Kumazawa et al; J. Med. Chem, (1994), 37(6), 804-810.

M.A. Davis et al; J. Med. Chem., (1964), Vol(7), 88-94.

15

Sestanj, K; Can. J. Chem., (1971), 49, 664-665.

Burtner, R. ; J. Am. Chem. Soc., (1943), 65, 1582-1585

Heacock R.A. et al; Ann. Appl. Biol., (1958), 46(3), 352-365.

Rigaudy J. et.al; Bull. Soc. Chim. France, (1959), 638-43.

Ueda I. et al; Bull. Chem. Soc. Jpn; (1975), 48 (8), 2306-2309.

20

E.L. May et.al.; J. Am. Chem. Soc., (1948), 70, 1077-9.

Also included within the scope of the present invention are pharmaceutical composition which comprise, as the active ingredient, at least one quinuclidine derivative of general formula (I) in association with a pharmaceutically acceptable carrier or diluent. Preferably the composition is made up in a form suitable for oral administration.

25

The pharmaceutically acceptable carrier or diluents which are mixed with the active compound or compounds, to form the composition of this invention are well-known *per se* and the actual excipients used depend *inter alia* on the intended method of administration of the composition.

30

Compositions of this invention are preferably adapted for oral administration. In this case, the composition for oral administration may take the form of tablets, film-coated tablets, liquid inhalant, powder inhalant and inhalation aerosol; all containing one or more

35



compounds of the invention; such preparations may be made by methods well-known in the art.

The diluents which may be used in the preparations of the compositions include those liquid and solid diluents which are compatible with the active ingredient, together with colouring or  
5      flavouring agents, if desired. Tablets or film-coated tablets may conveniently contain between 500 and 1 mg, preferably from 5 to 300 mg of active ingredient. The inhalant compositions may contain between 1  $\mu$ g and 1,000  $\mu$ g; preferably from 10 to 800  $\mu$ g of active ingredient. In  
10     human therapy, the dose of the compound of general formula (I) depend on the desired effect and duration of treatment; adult doses are generally between 3 mg and 300 mg per day as tablets and 10  $\mu$ g and 800  $\mu$ g per day as inhalant composition.

#### 15      Pharmacological Action

The following examples demonstrate the excellent pharmacological activities of the compounds of the present invention. The results on human muscarinic receptors binding and in the test on bronchospasm in  
20     guinea pig, were obtained as described below.

##### Human muscarinic receptor studies.

The binding of [ $^3$ H]-NMS to human muscarinic receptors was performed according to Waelbroek et al (1990) (1). Assays were carried  
25     out at 25°C. Membrane preparations from stably transfected chinese hamster ovary-K1 cells (CHO) expressing the genes for the human muscarinic receptors Hm3 were used.

For determination of  $IC_{50}$ , membrane preparations were suspended in DPBS to a final concentration of 89  $\mu$ g/ml for the Hm3 subtype. The  
30     membrane suspension was incubated with the tritiated compound for 60 min. After incubation the membrane fraction was separated by filtration and the bound radioactivity determined. Non specific binding was determined by addition of  $10^{-4}$  M atropine. At least six concentrations were assayed in duplicate to generate individual  
35     displacement curves.

COMPOUNDS No	BINDING TO RECEPTOR M <sub>2</sub> (IC <sub>50</sub> nM)
ATROPINE	3.2
IPRATROPIUM	3.0
1	31
2	15
7	22
8	4.8
17	14
18	6.6
20	6.8
35	13
36	2.7
39	3.8
44	4.4
53	5.6
71	8.2
74	16
77	3.1
78	5
84	9.9
89	5.4
99	31
100	14

101	7.6
109	31
114	14
116	23
126	13
127	16
128	8.8
129	6.3
136	11
137	6.9
138	19
146	13

(1) M. Waelbroek, M. Tastenoy, J. Camus, J Christophe. Binding of selective antagonists to four muscarinic receptors (M1 to M4) in rat forebrain. Mol. Pharmacol. (1990) 38: 267-273.

Our results show that the compounds of the present invention have affinities for the M<sub>3</sub> receptors which are very similar to the reference compounds.

The compounds of the invention preferably have high affinities for muscarinic M<sub>3</sub> receptors (HM3), preferably human muscarinic receptors. Affinity levels can typically be measured by *in vitro* assays, for example, as described above.

Preferred compounds of the invention have an IC<sub>50</sub> (nM) value for M<sub>3</sub> receptors of less than 35, preferably less than 25, 20 or 15, more preferably less than 10, 8 or 5.

#### Test on bronchospasm in guinea pig

The studies were performed according to Konzett and Rössler (2). Aqueous solutions of the agents to be tested were nebulized and inhaled

by anaesthetized ventilated male guinea pigs (Dunkin-Hartley). The bronchial response to intravenous acetylcholine challenge was determined before and after drug administration and the percent change in pulmonary resistance at several time-points.

- 5 2. Konzett H., Rössler F. Versuchsanordnung zu Untersuchungen an der bronchialmuskulatur. Arch. Exp. Path. Pharmacol. 195: 71-74 (1940)

The compounds of the present invention inhibited the bronchospasm response to acetylcholine with high potency and a long duration of action.

- 10 From the above described results one of ordinary skill in the art can readily understand that the compounds of the present invention have excellent antimuscarinic activity ( $M_3$ ) and thus are useful for the treatment of diseases in which the muscarinic  $M_3$  receptor is implicated, including respiratory diseases such as chronic obstructive  
15 pulmonary disease, chronic bronchitis, asthma and rhinitis, urinary diseases such as urinary incontinence and pollakinuria in neuripenia pollakinuria, neurogenic bladder, nocturnal enuresis, unstable bladder, cystospasm and chronic cystitis and gastrointestinal diseases such as irritable bowel syndrome, spastic colitis and diverticulitis.

- 20 The present invention further provides a compound of formula (I) or a pharmaceutically acceptable composition comprising a compound of formula (I) for use in a method of treatment of the human or animal body by therapy, in particular for the treatment of respiratory, urinary or gastrointestinal disease.

- 25 The present invention further provides the use of a compound of formula (I) or a pharmaceutically acceptable composition comprising a compound of formula (I) for the manufacture of a medicament for the treatment of respiratory, urinary or gastrointestinal disease.

- 30 Further, the compounds of formula (I) and pharmaceutical compositions comprising a compound of formula (I) can be used in a method of treating respiratory, urinary or gastrointestinal disease, which method comprises administering to a human or animal patient in need of such treatment an effective amount of a compound of formula (I) or a pharmaceutical composition comprising a compound of formula (I).

- 35 The present invention will be further illustrated by the

following examples. The examples are given by way of illustration only and are not to be construed as limiting.

#### Example 1

5     **3(R)-Diphenylacetoxy-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2] octane; bromide**

The title compound was synthesised according to methods d and a. The yield of final step was 500 mg , 81%. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.72-2.18 (m, 6H), 2.35 (m, 1H), 3.0 (m, 1H), 3.23 (m, 1H), 3.59-3.88(m, 5H), 4.0  
10 (m, 2H), 4.30 (m, 1H), 5.1 (s, 1H), 5.25 (m, 1H), 6.8-6.9 (m, 2H), 6.9-7.0 (m, 1H), 7.2-7.4 (m, 12H); MS [M-Br]<sup>+</sup>: 456; mp 129 °C.

#### Example 2

15     **3(R)-(2-Hydroxy-2,2-diphenylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 280 mg ,42%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5 - 1.7 (m, 2H), 1.9 - 2.1 (m, 4H), 2.3 (m, 1H), 3.1 (m, 1H), 3.2 - 3.5 (m, 6H), 3.9 - 4.1 (m, 3H), 5.25 (m, 1H), 6.8 (bs, OH), 6.95 (m,  
20 3H), 7.2 - 7.5 (m, 12H); MS [M-Br]<sup>+</sup>: 472; mp 199°C.

#### Example 3

25     **3(R)-[2,2-Bis(4-fluorophenyl)-2-hydroxyacetoxy]-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 400 mg ,85%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.65 (m, 1H), 1.7-1.8 (m, 1H), 1.85-2.0 (m, 2H), 2.05-2.2 (m, 2H), 2.3 (m, 1H), 3.1-3.2 (m, 1H), 3.3-3.5 (m, 6H), 3.95 (m, 1H), 4.05 (m, 2H), 5.25 (m, 1H), 6.9-7.0 (m, 4H), 7.1-7.5 (m, 10H); MS [M-Br]<sup>+</sup>: 508; mp 253°C.

30

#### Example 4

35     **3(R)-[2,2-Bis(4-fluorophenyl)-2-hydroxyacetoxy]-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 300 mg ,67%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.65 (m,

1H), 1.7-1.85 (m, 1H), 1.85-2.1 (m, 2H), 2.3 (m, 1H), 2.9-3.1 (m, 2H), 3.15-3.25 (m, 1H), 3.3-3.6 (m, 6H), 3.95-4.05 (m, 1H), 5.25 (m, 1H), 6.95 (s, OH), 7.1-7.5 (m, 13H); MS [M-Br]<sup>+</sup>: 478; mp 182°C.

5     **Example 5**

**3(R)-(2-Hydroxy-2,2-di-p-tolylacetoxy)-1-(3-phenoxypropyl)-1-azonia bicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 500 mg, 54%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55-1.8 (m, 2H), 1.85-2.0 (m, 2H), 2.05-1.15 (m, 2H), 2.3 (s, 7H), 3.05-3.15 (m, 1H), 3.25-3.5 (m, 6H), 3.95 (m, 1H), 4.05 (t, 2H), 5.2 (m, 1H), 6.8 (s, OH), 6.95 (m, 3H), 7.1-7.2 (m, 4H), 7.2-7.35 (m, 6H); MS [M-Br]<sup>+</sup>: 500; mp 183°C.

15     **Example 6**

**3(R)-(2-Hydroxy-2,2-di-p-tolylacetoxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 650 mg, 74%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55-1.8 (m, 2H), 1.85-2.05 (m, 2H), 2.25 (s, 7H), 2.9-3.05 (m, 2H), 3.1-3.25 (m, 1H), 3.3-3.55 (m, 6H), 3.95 (m, 1H), 5.25 (m, 1H), 6.8 (s, OH), 7.1-7.2 (m, 4H), 7.2-7.35 (m, 9H); MS [M-Br]<sup>+</sup>: 470; mp 144°C.

**Example 7**

25     **3(R)-(2,2-Diphenylpropionyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods e and a. The yield of final step was 250 mg, 61%. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.47-1.60 (m, 1H), 1.8-2.0 (m, 1H), 2.0 (s, 3H), 2.0-2.15 (m, 4H), 2.39 (s, 1H), 2.6 (m, 1H), 2.92 (d, 1H), 3.6 (m, 1H), 3.7-3.9 (m, 4H), 4.0 (m, 2H), 4.3 (m, 1H), 5.25 (m, 1H), 6.85 (m, 2H), 7.0 (m, 1H), 7.3 (m, 12H); MS [M-Br]<sup>+</sup>: 470; mp 186 °C.

**Example 8**

35     **3(R)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-**

**azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised as a mixture of diastereomers according to methods c and a. The yield of final step was 520 mg , 62%.

<sup>1</sup> H- NMR (DMSO-d<sub>6</sub>): δ 1.5 - 1.95 (m, 4H), 2.1 (m, 2H), 2.3 (m, 1H),  
5 3.1 (m, 1H), 3.3 - 3.5(m, 6H), 3.9 (m, 1H), 4.05 (t, 2H), 5.2 (m, 1H),  
7.0 (m, 4H), 7.15 (m, 2H), 7.35 (m, 5H), 7.5 (m, 3H); MS [M-Br]<sup>+</sup>: 478;  
mp 220°C.

**Example 9**

10 **3(R)-[2(R)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxy)]-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 1. The yield of final step was 10 mg ,  
23%. <sup>1</sup> H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.6 (m, 1H), 1.65-1.75 (m, 1H), 1.8-2.0  
15 (m, 2H), 2.05-2.1 (m, 2H), 2.3 (m, 1H), 3.05-3.2 (m, 1H), 3.25-3.55  
(m, 6H), 3.85-3.95 (m, 1H), 4.0 (t, 2H), 5.2 (m, 1H), 6.95 (m, 3H), 7.03  
(m, 1H), 7.15 (dd, 1H), 7.2 (s, OH), 7.3-7.5 (m, 5H), 7.45-7.55 (m,  
3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 478.

**Example 10**

20 **3(R)-[2(S)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxy)]-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 2. The yield of final step was 3 mg ,  
11%. <sup>1</sup> H- NMR (DMSO-d<sub>6</sub>): δ 1.6-1.75 (m, 2H), 1.8-2.0 (m, 4H), 2.25 (m,  
25 1H), 2.8 (t, 2H), 2.95-3.1 (m, 1H), 3.15-3.5 (m, 6H), 3.8-3.95 (m, 1H),  
5.2 (m, 1H), 6.92 (m, 1H), 6.96-7.03 (m, 2H), 7.1 (dd, 1H), 7.18 (s,  
OH), 7.3-7.4 (m, 4H), 7.43-7.5 (m, 2H), 7.51 (dd, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>:  
478.

30 **Example 11**

**3(R)-[2(R)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxy)]-1-(3-phenylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 1. The yield of final step was 9 mg ,  
35 22%. <sup>1</sup> H- NMR (DMSO-d<sub>6</sub>): δ 1.45-1.55 (m, 1H), 1.65-1.75 (m, 1H),

1.85-2.05 (m, 2H), 2.3 (m, 1H), 2.9-3.1 (m, 2H), 3.1-3.25 (m, 1H), 3.25-3.55 (m, 6H), 3.9-4.0 (m, 1H), 5.25 (m, 1H), 7.05 (m, 1H), 7.15 (m, 1H), 7.2 (m, 1H), 7.25-7.4 (m, 8H), 7.45 (m, 2H), 7.55 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 448.

5

**Example 12**

3(R)-[2(R)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxyl)-1-(3-phenylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 1. The yield of final step was 11 mg, 26%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.45-1.55 (m, 1H), 1.6-1.75 (m, 1H), 1.8-2.0 (m, 4H), 2.25 (m, 1H), 2.55 (t, 2H), 3.0-3.1 (m, 1H), 3.15-3.55 (m, 6H), 3.8-3.9 (m, 1H), 5.2 (m, 1H), 7.0 (m, 1H), 7.1 (m, 1H), 7.15-7.4 (m, 9H), 7.45 (m, 2H), 7.5 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 462.

15

**Example 13**

3(R)-[2(R)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxyl)-1-(2-thien-2-ylethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 1. The yield of final step was 10 mg, 24%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.45-1.55 (m, 1H), 1.65-1.75 (m, 1H), 1.8-2.0 (m, 2H), 2.3 (m, 1H), 3.1-3.6 (m, 9H), 3.9-4.0 (m, 1H), 5.25 (m, 1H), 7.0 (m, 3H), 7.15 (dd, 1H), 7.2 (s, OH), 7.3-7.4 (m, 3H), 7.45-7.55 (m, 4H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 454.

25

**Example 14**

3(R)-[2(R)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxyl)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 1. The yield of final step was 8 mg, 19%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.45-1.6 (m, 1H), 1.65-1.75 (m, 1H), 1.8-2.05 (m, 4H), 2.25 (m, 1H), 2.8 (t, 2H), 3.0-3.15 (m, 1H), 3.2-3.5 (m, 6H), 3.8-3.95 (m, 1H), 5.2 (m, 1H), 6.92 (m, 1H), 6.96-7.03 (m, 2H), 7.13 (dd, 1H), 7.2 (s, OH), 7.3-7.4 (m, 4H), 7.45-7.5 (m, 2H), 7.52 (dd, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 468.

35



**Example 15**

**3(R)-[2(S)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxyl)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 2. The yield of final step was 7 mg , 26%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.6-1.75 (m, 2H), 1.8-2.0 (m, 4H), 2.25 (m, 1H), 2.8 (t, 2H), 2.95-3.1 (m, 1H), 3.15-3.5 (m, 6H), 3.8-3.95 (m, 1H), 5.2 (m, 1H), 6.92 (m, 1H), 6.96-7.03 (m, 2H), 7.1 (dd, 1H), 7.18 (s, OH), 7.3-7.4 (m, 4H), 7.43-7.5 (m, 2H), 7.51 (dd, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 468.

**Example 16**

**3(R)-[2(R)-(2-Hydroxy-2-phenyl-2-thien-2-ylacetoxyl)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods f and b from intermediate I-4f, diastereomer 1. The yield of final step was 11 mg , 26%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.6 (m, 1H), 1.65-1.75 (m, 1H), 1.8-2.0 (m, 2H), 2.25 (m, 1H), 3.15-3.6 (m, 5H), 3.7 (m, 2H), 4.0 (m, 2H), 4.4 (m, 2H), 5.25 (m, 1H), 6.95-7.03 (m, 4H), 7.12 (dd, 1H), 7.2 (s, OH), 7.3-7.4 (m, 5H), 7.4-7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 464.

**Example 17**

**3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxyl)-1-(3-phenylallyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised as a mixture of diastereomers according to methods c and a. The yield of final step was 240 mg , 77%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.55-2.0 (m, 4H), 2.27 (m, 1H), 3.05-3.55 (m, 5H), 3.88-3.98 (m, 1H), 4.0-4.10 (m, 2H), 5.21 (m, 1H), 6.23-6.31 (doble dd, 1H), 6.36-6.48 (m, 2H), 6.83-6.90 (dd, 1H), 6.95 (d, OH), 7.26-7.66 (m, 11H); MS [M-Br]<sup>+</sup>: 444; mp 99°C.

**Example 18**

**3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxyl)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2] octane; bromide**

The title compound was synthesised as a mixture of diastereomers

according to methods c and a. The yield of final step was 210 mg , 66%.  
1H- NMR (DMSO-d6):  $\delta$  1.50-2.05 (m, 4H), 2.27 ( m, 1H), 3.20 (m, 1H),  
3.37-3.65 (m, 4H), 3.65-3.75 (m, 2H), 4.04 (m, 1H), 4.40 (m, 2H),  
5.21 (m, 1H), 6.23-6.32 (doble dd, 1H), 6.44 (m, 1H), 6.94-7.04 (m,  
5 4H), 7.33-7.50 (m, 7H), 7.64 (m, 1H); MS [M-Br]<sup>+</sup>: 448; mp 163°C.

#### Example 19

3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

10 The title compound was synthesised according to methods c and b from intermediate I-1a, diastereomer 1. The yield of final step was 11 mg, 23%. 1H- NMR (DMSO-d6):  $\delta$  1.65-1.80 (m, 2H), 1.80-2.10 (m, 2H), 2.27 (m, 1H), 3.15-3.65 (m, 5H), 3.68 (m, 2H), 4.0 (m, 1H), 4.40 (t, 2H), 5.20 (m, 1H), 6.23 (d, 1H), 6.42 (m, 1H), 6.92-7.04 (m, 4H), 7.30-7.38  
15 (m, 5H), 7.44-7.50 (m, 2H), 7.64 (m, 1H); MS [M-CF3COO]<sup>-</sup>: 448.

#### Example 20

3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-(3-phenoxypropyl)-1-  
20 azoniabicyclo[2.2.2] octane; bromide

The title compound has been described in method -a-.

#### Example 21

3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-(3-phenoxy propyl)-1-azoniabicyclo[2.2.2]octane; bromide  
25

The title compound was synthesised according to methods c and a from intermediate I-1a, diastereomer 1. The yield of final step was 1.15 g 99%. 1H- NMR (DMSO-d6):  $\delta$  1.60-2.20 (m, 6H), 2.25 (m, 1H), 3.10 (m, 1H), 3.20-3.60 (m, 6H), 3.95 (m, 1H), 4.05 (m, 2H), 5.20 (m, 1H),  
30 6.25 (dd, 1H), 6.45 (m, 1H), 6.95 (m, 4H), 7.30-7.50 (m, 7H), 7.70 (m, 1H); MS [M-Br]<sup>+</sup>: 462; mp 156°C.

#### Example 22

3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-(3-phenoxy propyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate  
35

The title compound was synthesised according to methods c and b from intermediate I-1a, diastereomer 2. The yield of final step was 10 mg, 20%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.50-2.20 (m, 6H), 2.25 (m, 1H), 3.10 (m, 1H), 3.20-3.60 (m, 6H), 3.95 (m, 1H), 4.05 (m, 2H), 5.20 (m, 1H), 6.35 (dd, 1H), 6.45 (m, 1H), 6.95 (m, 4H), 7.30-7.50 (m, 7H), 7.70 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 462.

#### Example 23

3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised as a mixture of diastereomers according to methods c and b. The yield of final step was 12 mg, 13%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5 (m, 1H), 1.7 (m, 1H), 1.9 - 2.05 (m, 2H), 2.3 (m, 1H), 2.95 (m, 2H), 3.15 (m, 1H), 3.25 - 3.55 (m, 6H), 3.95 (m, 1H), 5.25 (m, 1H), 6.3 (d, 1H), 6.45 (m, 1H), 6.95 (d, 1H), 7.25 - 7.45 (m, 8H), 7.5 (m, 2H), 7.7 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 432.

#### Example 24

3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-phenethyl-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b from intermediate I-1a, diastereomer 1. The yield of final step was 16 mg, 40%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65-1.80 (m, 2H), 1.90-2.05 (m, 2H), 2.3 (m, 1H), 2.95 (m, 2H), 3.15 (m, 1H), 3.25 - 3.55 (m, 6H), 3.95 (m, 1H), 5.25 (m, 1H), 6.26 (dd, 1H), 6.46 (m, 1H), 6.95 (s, 1H, OH), 7.25 - 7.45 (m, 8H), 7.5 (m, 2H), 7.7 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 432.

#### Example 25

3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-phenethyl-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b from intermediate I-1a, diastereomer 2. The yield of final step was 14 mg, 35%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.50-1.80 (m, 2H), 1.90-2.05 (m, 2H), 2.3 (m, 1H), 2.95 (m, 2H), 3.15 (m, 1H), 3.25 - 3.55 (m, 6H), 3.95

(m, 1H), 5.25 (m, 1H), 6.32 (dd, 1H), 6.46 (m, 1H), 6.95 (s, 1H, OH), 7.25 - 7.45 (m, 8H), 7.5 (m, 2H), 7.7 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 432.

5 **Example 26**

**3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-(3-phenylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b from intermediate I-1a, diastereomer 1. The yield of final step was 10 mg, 21%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.60-1.75 (m, 2H), 1.80-2.0 (m, 4H), 2.25 (m, 1H), 2.50-2.60 (m, 2H), 3.0 (m, 1H), 3.10-3.50 (m, 6H), 3.83 (m, 1H), 5.17 (m, 1H), 6.25 (d, 1H), 6.45 (m, 1H), 6.95 (s, 1H), 7.20-7.40 (m, 8H), 7.46-7.48 (m, 2H), 7.66 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 446.

15 **Example 27**

**3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-(2-thien-2-ylethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b from intermediate I-1a, diastereomer 1. The yield of final step was 9 mg, 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65-1.80 (m, 2H), 1.85-2.05 (m, 2H), 2.30 (m, 1H), 3.10-3.40 (m, 3H), 3.40-3.60 (m, 6H), 3.95 (m, 1H), 5.24 (m, 1H), 6.27 (d, 1H), 6.47 (m, 1H), 6.96 (s, 1H), 7.0-7.04 (m 2H), 7.36-7.48 (m, 4H), 7.49-7.54 (m, 2H), 7.70 (m, 1H).; MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 438.

25 **Example 28**

**3(R)-[2(\*)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)]-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b from intermediate I-1a, diastereomer 1. The yield of final step was 9 mg, 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.60-1.75 (m, 2H), 1.80-2.05 (m, 4H), 2.26 (m, 1H), 2.81 (t, 2H), 3.02 (m, 1H), 3.10-3.45 (m, 6H), 3.85 (m, 1H), 5.18 (m, 1H), 6.25 (d, 1H), 6.45 (m, 1H), 6.90-7.0 (m, 3H), 7.32-7.42 (m, 4H), 7.45-7.51 (m, 2H), 7.66 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 452.

35 **Example 29**

3(R)-(2-Furan-2-yl-2-hydroxy-2-thien-2-ylacetoxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised as a mixture of diastereomers according to methods c and b. The yield of final step was 18 mg, 20%.

5 <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.05 (m, 4H), 2.3 (m, 1H), 3.0 (m, 2H), 3.15 - 3.6 (m, 7H), 3.95 (m, 1H), 5.25 (m, 1H), 6.35 (dd, 1H), 6.45 (m, 1H), 7.05 (m, 1H), 7.2 (dd, 1H), 7.25 - 7.5 (m, 6H), 7.55 (m, 1H), 7.65 (m, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 438.

10 **Example 30**

3(R)-(2-Furan-2-yl-2-hydroxy-2-thien-2-ylacetoxy)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised as a mixture of diastereomers according to methods c and b. The yield of final step was 22 mg, 23%.

15 <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 2.65 - 2.05 (m, 4H), 2.3 (m, 1H), 3.15 - 3.65 (m, 7H), 4.05 (m, 1H), 4.4 (m, 2H), 5.15 (m, 1H), 6.35 (dd, 1H), 6.45 (m, 1H), 6.95 - 7.05 (m, 4H), 7.15 (d, 1H), 7.3 - 7.4 (m, 3H), 7.5 (dd, 1H), 7.65 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 454.

20 **Example 31**

3(R)-(2-Furan-2-yl-2-hydroxy-2-thien-2-ylacetoxy)-1-(4-oxo-4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised as a mixture of diastereomers according to methods c and b. The yield of final step was 15.4 mg, 15%.

25 <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.1 (m, 6H), 7.05 - 7.55 (m, 9H), 3.95 (m, 1H), 5.1 (m, 1H), 6.35 (dd, 1H), 6.5 (m, 1H), 7.05 (m, 1H), 7.15 (m, 1H), 7.3 (d, 1H), 7.55 (m, 3H), 7.7 (dd, 2H), 8.0 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 480.

30 **Example 32**

1-(3-phenoxypropyl)-3(R)-(2-Furan-2-yl-2-hydroxy-2-thien-2-yl-acetoxy)-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised as a mixture of diastereomers according to methods c and a. The yield of final step was 100 mg, 41%.

35 <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.05 (m, 4H), 2.1 - 2.0 (m, 2H), 2.3 (m,

1H), 3.15 (m, 1H), 3.25 - 3.6 (6H), 3.9 - 4.1 (m, 3H), 5.1 (m, 1H), 6.35 (d, 1H), 6.45 (s, 1H), 6.95 (m, 3H), 7.05 (m, 1H), 7.2 (d, 1H), 7.3 (m, 3H), 7.55 (d, 1H), 7.7 (s, 1H); MS [M-Br]<sup>+</sup>: 520; mp 173°C.

5

**Example 33**

**1-(3-phenoxypropyl)-3(R)-(2,2-difuran-2-yl-2-hydroxyacetoxyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods f and a. The yield of final step was 200 mg, 60%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.6-2.20 (m, 6H), 2.3 (m, 1H), 2.95-3.65 (m, 7H), 3.80-4.10 (m, 3H), 5.2 (m, 1H), 6.3-6.6 (m, 4H), 6.8-7.0 (m, 3H), 7.1 (s, OH), 7.3 (m, 2H), 7.7 (m, 2H); MS [M-Br]<sup>+</sup>: 452.

15 **Example 34**

**3(R)-(2,2-Dithien-2-ylacetoxyl)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 240 mg, 60%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.85-2.10 (m, 4H), 2.30 (s, 1H), 3.40 (m, 1H), 3.44-3.80 (m, 6H), 4.10 (m, 1H), 4.45 (m, 2H), 5.20 (m, 1H), 5.90 (s, 1H), 6.95-7.05 (m, 5H), 7.05-7.15 (m, 2H), 7.30-7.40 (m, 2H), 7.45 (m, 2H); MS [M-Br]<sup>+</sup>: 454; mp 98°C.

20 **Example 35**

**3(R)-(2,2-Dithien-2-ylacetoxyl)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 280 mg, 83%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.80-2.06 (m, 4H), 2.06-2.20 (m, 2H), 2.20-2.30 (m, 1H), 3.20-3.65 (m, 7H), 3.90-4.10 (m, 3H), 5.20 (m, 1H), 5.90 (s, 1H), 6.95-7.05 (m, 5H), 7.05-7.20 (m, 2H), 7.30-7.35 (m, 2H), 7.50 (m, 2H); MS [M-Br]<sup>+</sup>: 468; mp 148°C.

30 **Example 36**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxyl)-1-phenethyl-1-azoniabicyclo**

35

**[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 180 mg , 59%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (4H, m), 2.35 (m, 1H), 3.0 (m, 2H), 3.2 - 3.6 (m, 7H), 3.95 (m, 1H), 5.25 (m, 1H), 7.0 (m, 2H), 7.2 (m, 2H), 7.35 (m, 5H), 7.55 (m, 3H); MS [M-Br]<sup>+</sup>: 454; mp 216°C.

**Example 37****3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(3-phenylpropyl)-1-azonia bicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 450 mg , 58%. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.8 - 2.1 (m, 6H), 2.4 (m, 1H), 2.6 (m, 2H), 3.4 - 3.8 (m, 7H), 4.2 (m, 1H), 5.25 (m, 1H), 6.1 (bs, OH), 6.9 (m, 2H), 7.1 - 7.3 (m, 9H); MS [M-Br]<sup>+</sup>: 468; mp 64°C.

**Example 38****3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(3-phenylallyl)-1-azonia bicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 260 mg , 34%. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.8 - 2.05 (m, 4H), 2.4 (m, 1H), 3.55 - 3.95 (m, 5H), 4.15 - 4.5 (m, 3H), 5.25 (m, 1H), 5.9 (s, OH), 6.15 (m, 1H), 6.85 (t, 1H), 6.9 - 7.05 (m, 3H), 7.15 (m, 1H), 7.2 - 7.45 (m, 7 H); MS [M-Br]<sup>+</sup>: 466; mp 124°C.

**Example 39****3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(4-phenylbutyl)-1-azonia bicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 320 mg , 40%. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.6 - 2.0 (m, 8H), 2.4 (m, 1H), 2.6 (m, 2H), 3.4 - 3.8 (m, 7H), 4.2 (m, 1H), 5.25 (m, 1H), 6.05 (bs, OH), 6.95 (m, 2H), 7.1 - 7.3 (m, 9H); MS [M-Br]<sup>+</sup>: 482; mp 64°C.

**Example 40**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(4-oxo-4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 16 mg , 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 - 2.0 (m, 6H), 2.15 (m, 1H), 3.1 (t, 2H), 3.15 - 3.55 (m, 7H), 3.95 (m, 1H), 5.25 (m, 1H), 7.0 (d, 2H), 7.15 (d, 2H), 7.55 (m, 5H), 7.65 (t, 1H), 8.0 (d, 2H); MS[M-CF<sub>3</sub>COO]<sup>+</sup>: 496.

**Example 41**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(3-phenylaminopropyl)-1-azoniabicyclo[2.2.2] octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 14 mg , 14%. <sup>1</sup>H- NMR ( DMSO-d<sub>6</sub>): δ 1.7 - 2.0 (m, 5H), 2.3 (m, 1H), 3.0 - 3.5 (m, 9H), 3.9 (m, 1H), 5.25 (m, 1H), 5.65 (t, 1H), 6.55 (m, 3H), 7.0 (d, 2H), 7.1 (t, 2H), 7.15 (m, 2H), 7.5 (m, 3H); MS[M-CF<sub>3</sub>COO]<sup>+</sup>: 483.

**Example 42**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(methylphenylamino)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 20 mg , 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 6H), 2.9 (s, 3H), 3.1 (m, 1H), 3.2 - 3.45 (m, 8H), 3.95 (m, 1H), 5.2 (m, 1H), 6.65 (t, 1H), 6.75 (d, 2H), 7.0 (m, 2H), 7.2 (m, 4H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 497.

**Example 43**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(3-phenylsulfanylpropyl)-1-azoniabicyclo[2.2.2] octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 800 mg , 83%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.6 -1.9 (m, 6H), 2.3 (m, 1H), 2.95 (t, 2H), 3.05 (m, 1H), 3.2 - 3.5 (m, 6H), 3.9 (m, 1H), 5.2 (m, 1H), 7.0 (m, 2H), 7.15 (m, 2H), 7.2 (m, 1H), 7.35 (m, 4H), 7.5 (m, 2H); MS [M-Br]<sup>+</sup>: 500.



**Example 44**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2] octane; bromide**

The title compound was synthesised according to methods c and a. The  
5 yield of final step was 490 mg, 90%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 (m, 2H),  
1.95 (m, 2H), 2.1 (m, 2H), 2.3 (m, 1H), 3.2 (m, 1H), 3.45 (m, 6H), 4.0  
(m, 3H), 5.15 (m, 1H), 6.9 (m, 3H), 7.0 (m, 2H), 7.2 (m, 2H), 7.3 (t,  
2H), 7.5 (m, 3H); MS [M-Br]<sup>+</sup>: 484; mp 227°C.

**Example 45**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-o-tolyloxypropyl)-1-azoniabicyclo[2.2.2] octane; trifluoroacetate**

The title compound was synthesised according to methods c and b The  
yield of final step was 19 mg , 18%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.7- 2.0 (m,  
15 4H), 2.1 - 2.2 (m, 5H), 2.3 (m, 1H), 3.15 - 3.5 (m, 7H), 3.9 - 4.05 (m,  
3H), 5.05 (m, 1H), 6.85 (t, 1H), 6.9 (d, 1H), 7.0 (m, 2H), 7.15 (m,  
4H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 498.

**Example 46**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(2,4,6-trimethylphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 22 mg , 20%. <sup>1</sup>H- NMR ( DMSO-d<sub>6</sub>): δ 1.7(m, 2H),  
1.95 (m, 2H), 2.1 (m, 2H), 2.2 (s, 9H), 2.35 (m, 1H), 3.2 - 3.5 (m,  
25 7H), 3.7 (t, 2H), 3.95 (m, 1H), 5.25 (m, 1H), 6.8 (s, 2H), 7.0 (m, 2H),  
7.2 (m, 2H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 526.

**Example 47**

**1-[3-(2-tert-Butyl-6-methylphenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 18 mg , 16%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.3 (s, 9H),  
2.7 (m, 2H), 2.9 (m, 2H), 2.1 (m, 2H), 2.2 (s, 3H), 2.3 (m, 1H), 3.2  
- 3.5 (m, 7H), 3.8 (t, 2H), 3.95 (m, 1H), 5.2 (m, 1H), 6.9 - 7.15 (m,  
35 7H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 554.

**Example 48**

1-[3-(Biphenyl-4-yloxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo[2.2.2]-octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The  
5 yield of final step was 22 mg , 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 (m, 2H),  
1.9 (m, 2H), 2.15 (m, 2H), 2.3 (m, 1H), 3.2 - 3.5 (m, 7H), 3.95 (m, 1H),  
4.1 (t, 2H), 5.25 (m, 1H), 7.0 (m, 4H), 7.2 (m, 2H), 7.3 (t, 1H), 7.45  
(t, 2H), 7.5 (m, 3H), 7.6 (m, 4H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 560.

**Example 49**

3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(5,6,7,8-tetrahydronaphthalen-2-yloxy)-propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The  
15 yield of final step was 23 mg , 21%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 (m, 6H),  
1.9 - 2.1 (m, 4H), 2.3 (m, 1H), 2.65 (m, 4H), 3.15 - 3.5 (m, 7H), 3.95  
(m, 2H), 5.25 (m, 1H), 6.65 (m, 2H), 6.95 (d, 1H), 7.0 (m, 2H), 7.2  
(m, 2H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 538.

**Example 50**

3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(naphthalen-2-yloxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The  
yield of final step was 17 mg , 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 - 2.0 (m,  
25 4H), 2.1 (m, 1H), 2.35 (m, 1H), 3.15 - 3.35 (m, 7H), 3.95 (m, 1H), 4.17  
(t, 2H), 5.25 (m, 1H), 7.0 (m, 2H), 7.15 (m, 3H), 7.35 (m, 2H), 7.5 (m,  
4H), 7.85 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 534.

**Example 51**

30 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(naphthalen-1-yloxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound has been described in method -b-.

**Example 52**

35 1-[3-(2-Chlorophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox

**y)-1-azoniabicyclo [2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 20 mg , 18%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 6H), 2.35 (m, 1H), 3.2 (m, 1H), 3.3 - 3.55 (m, 6H), 3.95 (m, 1H), 4.15 (t, 2H), 5.25 (m, 2H), 7.0 (m, 3H), 7.2 (m, 3H), 7.35 (t, 1H), 7.45 (d, 1H), 7.55 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 519.

**Example 53****1-[3-(4-Fluorophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo [2.2.2]octane; chloride**

The title compound was synthesised according to methods c and a. The yield of final step was 180 mg , 59%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.15 (m, 6H), 2.25 (m, 1H), 3.2 (m, 1H), 3.25 - 3.55 (m, 6H), 3.95 (m, 2H), 4.0 (t, 2H), 5.25 (m, 1H), 7.0 (m, 4H), 7.15 (m, 4H), 7.55 (m, 3H); MS [M-Cl]<sup>+</sup>: 502; mp 160 °C.

**Example 54****1-[3-(2,4-Difluorophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 14 mg , 13%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 4H), 2.15 (m, 2H), 2.35 (m, 1H), 3.2 (m, 1H), 3.25 - 3.35 (m, 6H), 3.95 (m, 1H), 4.1 (t, 2H), 5.15 (m, 1H), 7.05 (m, 3H), 7.2 (d, 2H), 7.25 - 7.35 (m, 2H), 7.55 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 520.

**Example 55****3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(3-trifluoromethylphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg , 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.1 (m, 6H), 2.35 (m, 1H), 3.2 (m, 1H), 3.3 - 3.55 (m, 6H), 3.95 (m, 1H), 4.15 (t, 2H), 5.25 (m, 1H), 7.0 (m, 2H), 7.2 (m, 2H), 7.25 - 7.35 (m, 3H), 7.5 - 7.6 (m, 4H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 552.

**Example 56**

**1-[3-(3-Cyanophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo [2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
5 yield of final step was 18 mg , 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.1  
(m, 6H), 2.35 (m, 1H), 3.2 (m, 1H), 3.3 - 3.55 (m, 6H), 3.95 (m, 1H),  
4.15 (t, 2H), 5.25 (m, 1H), 7.0 (m, 2H), 7.18 (m, 2H), 7.3 (d,  
1H), 7.45 (m, 2H), 7.55 (m, 4H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 509.

**10 Example 57**

**1-[3-(4-Cyanophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo [2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The  
yield of final step was 180 mg , 53%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.2  
15 (m, 6H), 2.3 (m, 1H), 3.2 (m, 1H), 3.3 - 3.55 (m, 6H), 3.95 (m, 1H),  
4.15 (t, 2H), 5.25 (m, 1H), 7.0 (m, 2H), 7.1 (d, 2H), 7.15 (m, 2H),  
7.5 (m, 2H), 7.8 (d, 2H); MS [M-Br]<sup>+</sup>: 509; mp 158°C.

**Example 58**

**20 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(3-methoxyphenoxy)propyl]-1-azonia bicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 19 mg , 18%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.15  
(m, 6H), 2.15 (m, 1H), 3.2 (m, 1H), 3.3 - 3.5 (m, 6H), 3.75 (s, 3H),  
25 3.95 (m, 1H), 4.0 (t, 2H), 5.25 (m, 1H), 6.55 (m, 3H), 7.0 (m, 2H), 7.2  
(m, 3H), 7.55 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 514.

**Example 59**

**30 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(4-methoxyphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 14 mg , 13%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.15  
(m, 6H), 2.35 (m, 1H), 3.2 (m, 1H), 3.3 - 3.55 (m, 6H), 3.7 (s, 3H),  
3.9 - 4.0 (m, 3H), 5.25 (m, 1H), 6.9 (s, 4H), 7.0 (m, 2H), 7.15 (m, 2H),  
35 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 514.

**Example 60**

1-[3-(Benzo[1,3]dioxol-5-yloxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg , 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.15 (m, 7H), 2.3 (m, 1H), 3.15 (m, 1H), 3.25 - 3.5 (m, 6H), 3.9 - 4.0 (m, 3H), 5.25 (m, 1H), 5.95 (s, 2H), 6.4 (d, 1H), 6.65 (s, 1H), 6.85 (d, 1H), 7.0 (m, 2H), 7.2 (m, 2H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 528.

**Example 61**

1-[3-(2-Carbamoylphenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The yield of final step was 18 mg , 16%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 4H), 2.2 (m, 2H), 2.3 (m, 1H), 3.15 (m, 1H), 3.25 - 3.55 (m, 6H), 3.95 (m, 1H), 4.15 (t, 2H), 5.25 (m, 1H), 7.0 - 7.2 (m, 6H), 7.4 - 7.6 (m, 6H), 7.7 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 527.

**Example 62**

1-[3-(3-Dimethylaminophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetox)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg , 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.15 (m, 6H), 2.3 (m, 1H), 2.85 (s, 6H), 3.1 - 3.5 (m, 7H), 3.85 - 4.0 (m, 3H), 5.25 (m, 1H), 6.2 (m, 1H), 6.25 (d, 1H), 6.35 (d, 1H), 7.0 (m, 2H), 7.1 (t, 1H), 7.2 (m, 2H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 527.

**Example 63**

3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(4-nitrophenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The yield of final step was 22 mg , 20%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 4H), 2.2 (m, 2H), 2.3 (m, 1H), 3.2 (m, 1H), 3.3 - 3.5 (m, 6H), 3.95 (m, 1H), 4.2 (t, 2H), 5.25 (m, 1H), 7.0 (m, 2H), 7.15 (m, 4H), 7.5 (m, 3H), 8.15 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 529.

**Example 64**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(3-nitrophenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
5 yield of final step was 18 mg , 16%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.2 (m, 6H), 2.3 (m, 1H), 3.15 - 3.55 (m, 7H), 3.95 (m, 1H), 4.2 (t, 2H), 5.25 (m, 1H), 7.0 (m, 2H), 7.2 (m, 2H), 7.45 (dd, 1H), 7.55 (m, 3H), 7.6 (t, 1H), 7.75 (s, 1H), 7.85 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 529.

**10 Example 65**

**1-[3-(4-Acetylaminophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
15 yield of final step was 19 mg , 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.15 (m, 6H), 2.0 (s, 3H), 2.3 (m, 1H), 3.2 (m, 1H), 3.3 - 3.55 (m, 6H), 3.9 - 4.0 (m, 3H), 5.25 (m, 1H), 6.85 (d, 2H), 7.0 (m, 2H), 7.2 (m, 2H), 7.5 (m, 5H), 9.8 (s, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 541.

**Example 66**

**20 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(3-methoxycarbonylphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 18 mg , 16%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.2 (m, 6H), 2.3 (m, 1H), 3.2 (m, 1H), 3.3 - 3.5 (m, 6H), 3.85 (s, 3H),  
25 3.95 (m, 1H), 4.1 (t, 2H), 5.25 (m, 1H), 7.0 (m, 2H), 7.15 (m, 2H), 7.25 (dd, 1H), 7.45 - 7.6 (m, 6H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 542.

**Example 67**

**30 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-{3-[4-(3-hydroxypropyl)phenoxy]propyl}-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 14 mg , 13%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.6 - 2.15 (m, 8H), 2.3 (m, 1H), 2.55 (t, 2H), 3.2 (m, 1H), 3.25 - 3.55 (m, 9H), 3.85 - 4.0 (m, 3H), 4.45 (t, OH), 5.25 (m, 1H), 7.85 (d, 2H), 7.0  
35 (m, 2H), 7.1 (d, 2H), 7.15 (m, 2H), 7.5 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 542.

**Example 68**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(2-hydroxymethylphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

5 The title compound was synthesised according to methods c and b. The yield of final step was 16 mg , 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 - 2.2 (m, 6H), 2.35 (m, 1H), 3.1 - 3.5 (m, 7H), 3.9 - 4.05 (m, 3H), 4.5 (m, 2H), 5.0 (t, OH), 5.15 (m, 1H), 6.9 - 7.05 (m, 4H), 7.2 (m, 2H), 7.4 (d, 1H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 514.

10

**Example 69**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(3-hydroxymethylphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

15 The title compound was synthesised according to methods c and b. The yield of final step was 16 mg , 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 - 2.2 (m, 6H), 2.35 (m, 1H), 3.15 - 3.5 (m, 7H), 3.9 (m, 1H), 4.05 (t, 2H), 4.45 (d, 2H), 5, 25 (m, 2H), 6.8 (d, 1H), 6.9 (m, 2H), 7.2 (m, 2H), 7.25 (t, 1H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 514.

20

**Example 70**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(4-hydroxymethylphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

25 The title compound was synthesised according to methods c and b. The yield of final step was 17 mg , 16%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.2 (m, 6H), 2.3 (m, 1H), 3.15 - 3.55 (m, 7H), 3.9 - 4.05 (m, 3H), 4.4 (d, 2H), 5.1 (t, OH), 5.25 (t, 1H), 6.9 (d, 2H), 7.0 (m, 2H), 7.2 (m, 2H), 7.25 (d, 2H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 514.

**Example 71**

30 **3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(2-hydroxyphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

35 The title compound was synthesised according to methods c and b. The yield of final step was 24 mg , 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.15 (m, 6H), 2.35 (m, 1H), 3.2 (m, 1H), 3.25 - 3.55 (m, 6H), 3.95 (m, 1H), 4.0 (t, 2H), 5.25 (m, 1H), 6.7 - 6.85 (m, 3H), 6.95 (d, 1H),

7.0 (m, 2H), 7.2 (m, 2H), 7.5 (m, 3H), 8.85 (s, OH); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 500.

#### Example 72

5    **3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(4-hydroxyphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 16 mg, 15%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.65-2.1 (m, 6H), 2.3 (m, 1H), 3.2 (m, 1H), 3.25-3.5 (m, 6H), 3.95 (m, 3H),  
10    5.25 (m, 1H), 6.7 (d, 2H), 6.75 (d, 2H), 7.0 (m, 2H), 7.2 (m, 2H), 7.5 (t, 3H), 9.0 (s, OH); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 500.

#### Example 73

15    **3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-[3-(3-hydroxyphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 16 mg, 15%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.65-2.15 (m, 6H), 2.3 (m, 1H), 3.2 (m, 1H), 3.3-3.55 (m, 6H), 3.9-4.0 (m, 3H), 5.25 (m, 1H), 6.9-6.0 (m, 3H), 7.0-7.1 (m, 3H), 7.2 (m,  
20    2H), 7.5 (m, 3H), 9.45 (s, OH); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 500.

#### Example 74

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(3-pyrrol-1-ylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

25    The title compound was synthesised according to methods c and b. The yield of final step was 21 mg, 22%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.65-1.8 (m, 2H), 1.8-2.0 (m, 2H), 2.0-2.15 (m, 2H), 2.3 (m, 1H), 3.05-3.2 (m, 3H), 3.2-3.5 (m, 4H), 3.8-3.95 (m, 3H), 5.2 (m, 1H), 6.05 (t, 2H), 6.75 (t, 2H), 7.0 (t, 2H), 7.15 (d, 2H), 7.55 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 457.  
30

#### Example 75

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetox)-1-(4-oxo-4-thien-2-ylbutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

35    The title compound was synthesised according to methods c and b. The



yield of final step was 18 mg , 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7-1.85 (m, 2H), 1.9-2.1 (m, 4H), 2.3 (m, 1H), 3.1 (t, 2H), 3.15-3.55 (m, 7H), 3.95 (m, 1H), 5.25 (m, 1H), 7.0 (t, 2H), 7.4 (d, 2H), 7.25 (t, 1H), 7.55 (m, 3H), 7.95 (d, 1H), 8.05 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 502.

5

**Example 76**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxyl)-1-[3-(1-methyl-[1H]-imidazol-2-ylsulfanyl)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

10 The title compound was synthesised according to methods c and b. The yield of final step was 26 mg , 25%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 (m, 2H), 1.85 - 2.05 (m, 4H), 2.3 (m, 1H), 3.25 - 3.5 (m, 7H), 3.6 (s, 3H), 3.9 (m, 1H), 4.2 (t, 2H), 5.2 (m, 1H), 7.0 (m, 3H), 7.15 (m, 2H), 7.3 (m, 1H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 504.

15

**Example 77**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxyl)-1-(2-thien-2-ylethyl)-1-azoniabicyclo[2.2.2]octane; bromide**

20 The title compound was synthesised according to methods c and a. The yield of final step was 430 mg , 54%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.6-1.8 (m, 2H), 2.3 (m, 1H), 3.15-3.3 (m, 4H), 3.35-3.55 (m, 5H), 3.95 (m, 1H), 5.25 (m, 1H), 7.0 (m, 4H), 7.15 (m, 2H), 7.4-7.5 (m, 4H); MS [M-Br]<sup>+</sup>: 460; mp 206°C.

25

**Example 78**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxyl)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

30 The title compound was synthesised according to methods c and a. The yield of final step was 600 mg , 77%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.6 -1.8 (m, 2H), 1.85 - 2.1 (m, 4H), 2.3 (m, 1H), 2.8 (t, 2H), 3.1 - 3.5 (m, 7H), 3.9 (m, 1H), 5.2 (m, 1H), 6.9 - 7.05 (m, 4H), 7.15 (m, 2H), 7.4 (d, 1H), 7.5 (m, 3H); MS [M-Br]<sup>+</sup>: 474; mp 138°C.

**Example 79**

35 **1-[3-(Benzothiazol-2-yloxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-**

**ylacetoxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 23 mg , 21%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.1 (m, 6H); 2.3 (m, 1H), 3.15 (m, 1H), 3.25 - 3.5 (m, 6H), 3.85 (m, 1H), 4.0 (t, 2H), 5.2 (m, 1H), 7.0 (t, 2H), 7.15 (m, 2H), 7.25 (m, 1H), 7.45 (m, 5H), 7.7 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 541.

**Example 80****1-(3-Benzoyloxypropyl)-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2] octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 16 mg , 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 (m, 2H), 1.9 (m, 4H), 2.3 (m, 1H), 3.1 - 3.4 (m, 7H), 3.5 (t, 2H), 3.9 (m, 1H), 3.9 (s, 2H), 5.2 (m, 1H), 7.0 (m, 2H), 7.15 (m, 2H), 7.35 (m, 5H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 498.

**Example 81****3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[6-(4-phenylbutoxy)hexyl]-1-azoniabicyclo [2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 560 mg , 60%. <sup>1</sup>H- NMR (CDCl<sub>3</sub>): δ 1.2 -1.75 (m, 16H), 1.8 - 2.1 (m, 4H), 2.4 (m, 1H), 2.6 (t, 2H), 3.3 - 3.75 (m, 11H), 4.2 (m, 1H), 5.3 (m, 1H), 6.0 (bs, OH), 6.95 (m, 2H), 7.15 - 7.3 (m, 9H); MS [M-Br]<sup>+</sup>: 582.

**Example 82****3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(4-phenoxybutyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 240 mg ; 30%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>/CDCl<sub>3</sub>): δ 1.8 - 1.95 (m, 6H), 2.1 (m, 2H), 2.45 (m, 1H), 3.18 (m, 1H), 3.5 - 3.8 (m, 6H), 4.0 (t, 2H), 4.15 (m, 1H), 5.15 (m, 1H), 6.7 (s, OH), 6.9 (m, 5H), 7.15 (d, 1H), 7.25 (m, 5H); MS [M-Br]<sup>+</sup>: 498; mp 161°C.

**Example 83**

**3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 380 mg , 50%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.85 (m, 2H), 2.05 (m, 2H), 2.4 (m, 1H), 3.6 - 4.1 (m, 7H), 4.35 (m, 3H), 5.25 (m, 1H), 6.0 (bs, OH), 6.9 (m, 4H), 7.0 (t, 1H), 7.1 (dd, 2H), 7.2 (dd, 2H), 7.3 (t, 2H); MS [M-Br]<sup>+</sup>: 470; mp 48°C.

**Example 84**

**1-(2-Benzoyloxyethyl)-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 17 mg , 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 4H), 2.3 (m, 1H), 3.2 - 3.55 (m, 7H), 3.85 (m, 2H), 4.5 (s, 2H), 5.25 (m, 1H), 7.0 (t, 2H), 7.15 (t, 2H), 7.3 - 7.4 (m, 4H), 7.5 (m, 3H); MS [M-CF<sub>3</sub>COO]<sup>-</sup>: 484.

**Example 85**

**3(S)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2] octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 600 mg , 54%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>/CDCl<sub>3</sub>): δ 1.85 - 2.3 (m, 6H), 2.5 (m, 1H), 3.3 (m, 1H), 3.4 (d, 1H), 3.5 - 3.7 (m, 5H), 4.05 (t, 2H), 4.2 (m, 1H), 5.25 (m, 1H), 6.85 (d, 2H), 7.0 (m, 3H), 7.15 (m, 2H), 7.2 (d, 1H), 7.3 (m, 4H); MS [M-Br]<sup>+</sup>: 484; mp 230°C.

**Example 86**

**4-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods f and a. The yield of final step was 290 mg, 60%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 2.15 (m, 2H), 2.35 (m, 6H), 3.35 (m, 2H), 3.65 (m, 6H), 4.05 (t, 2H), 6.9 - 7.05 (m, 5H), 7.1 (m, 2H), 7.3 (m, 3H), 7.55 (m, 2H); MS [M-Br]<sup>+</sup>: 484; mp 168°C.

**Example 87**

4-(2-Hydroxy-2,2-dithien-2-yl-acetoxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods f and a. The  
5 yield of final step was 260 mg, 57%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 2.35 (m, 6H),  
3.0 (m, 2H), 3.4 (m, 2H), 3.75 (m, 6H), 7.0 (m, 2H), 7.3 - 7.5 (m, 6H),  
7.55 (m, 2H); MS [M-Br]<sup>+</sup>: 454; mp 195°C.

**Example 88**

10 1-(3-phenoxypropyl)-3(R)-(2,2-dithien-2-ylpropionyloxy)-1-  
azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods c and a. The  
yield of final step was 390 mg, 92%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65-2.20  
(m, 6H), 2.10 (s, 3H), 2.30 (bs, 1H), 3.10 (m, 1H), 3.30-3.60 (m, 6H),  
15 3.95-4.10 (m, 3H), 5.20 (m, 1H), 6.90-7.05 (m, 5H), 7.05-7.10 (m, 2H),  
7.25-7.35 (m, 2H), 7.50 (m, 2H); MS [M-Br]<sup>+</sup>: 482; mp 170°C.

**Example 89**

20 3(R)-(2-Hydroxy-2,2-dithien-3-ylacetoxy)-1-(3-phenoxypropyl)-1-  
azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods c and a. The  
yield of final step was 300 mg, 76%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.6 (m, 1H),  
1.75 (m, 1H), 1.8 - 2.0 (m, 2H), 2.0 - 2.2 (m, 2H), 2.3 (m, 1H),  
3.15 (m, 1H), 3.3 - 3.6 (m, 6H), 3.9 (m, 1H), 4.05 (t, 2H), 5.2 (m,  
25 1H), 6.75 (s, OH), 6.95 (m, 3H), 7.15 (m, 2H), 7.3 (t, 2H), 7.4  
- 7.5 (m, 4H); MS [M-Br]<sup>+</sup>: 484; mp 219°C.

**Example 90**

30 3(R)-(2-Hydroxy-2,2-dithienyl-3-ylacetoxy)-1-(3-thien-2-ylpropyl)-1-  
azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods c and a. The  
yield of final step was 300 mg, 77%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.6 (m,  
1H), 1.6-1.75 (m, 1H), 1.8-2.1 (m, 4H), 2.25 (m, 1H), 2.8 (t, 2H),  
3.05-3.5 (m, 7H), 3.8-3.95 (m, 1H), 5.15 (m, 1H), 6.75 (s, OH),  
35 6.9-7.0 (m, 2H), 7.1 (m, 2H), 7.35-7.55 (m, 5H); MS [M-Br]<sup>+</sup>: 474; mp

192°C.

**Example 91**

**3(R)-(2-Hydroxy-2,2-dithien-3-yl-acetoxy)-1-phenethyl-1-azoniabicyclo  
[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 63 mg, 48%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.7 (m,  
1H), 1.7-1.85 (m, 1H), 1.9-2.1 (m, 2H), 2.3 (m, 1H), 2.9-3.1 (m, 2H),  
3.15-3.6 (m, 7H), 3.9-4.0 (m, 1H), 5.2 (m, 1H), 6.8 (s, OH), 7.1 (m,  
2H), 7.25-7.35 (m, 5H), 7.4 (m, 2H), 7.5 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 454.

**Example 92**

**3(R)-(2-Hydroxy-2,2-dithien-3-yl-acetoxy)-1-(3-phenylpropyl)-1-azonia  
bicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 75 mg, 55%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-2.0 (m,  
6H), 2.25 (m, 1H), 2.5-2.6 (m, 2H), 3.05-3.6 (m, 8H), 3.8-3.9 (m,  
1H), 5.15 (m, 1H), 6.75 (s, OH), 7.1 (d, 2H), 7.2-7.35 (m, 5H), 7.4  
(m, 2H), 7.5 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 468.

**Example 93**

**3(R)-(2-Hydroxy-2,2-dithien-3-ylacetoxy)-1-(4-phenylbutyl)-1-azoniab  
icyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 68 mg, 48%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.8 (m,  
6H), 1.8-2.0 (m, 2H), 2.25 (m, 1H), 2.6 (m, 2H), 3.05 (m, 1H),  
3.15-3.45 (m, 6H), 3.85 (m, 1H), 5.15 (m, 1H), 6.75 (s, OH), 7.1 (d,  
2H), 7.2 (m, 2H), 7.3 (m, 3H), 7.4 (m, 2H), 7.5 (m, 2H); MS [M-  
CF<sub>3</sub>COO]<sup>+</sup>: 482.

**Example 94**

**3(R)-(2-Hydroxy-2,2-dithien-3-ylacetoxy)-1-(2-thien-2-ylethyl)-1-azo  
niabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The  
yield of final step was 65 mg, 49%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-1.65 (m,

1H), 1.65-1.78 (m, 1H), 1.85-2.05 (m, 2H), 2.3 (m, 1H), 3.1-3.6 (m, 9H), 3.95 (m, 1H), 5.2 (m, 1H), 6.75 (s, OH), 7.0 (m, 2H), 7.15 (m, 2H), 7.45 (m, 3H), 7.5 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 460.

5     **Example 95**

**3(R)-(2-Hydroxy-2,2-dithien-3-ylacetox)-1-(4-phenoxybutyl)-1-azonia bicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 63 mg, 43%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.5-2.0 (m, 8H), 2.3 (m, 1H), 3.1 (m, 1H), 3.2-3.5 (m, 6H), 3.85 (m, 1H), 4.0 (m, 2H), 5.2(m, 1H), 6.75 (s, OH), 6.95 (m, 3H), 7.1 (d, 2H), 7.2 (m, 2H), 7.3 (t, 2H), 7.45 (m, 2H), 7.5 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 498.

**Example 96**

15     **3(R)-(2-Hydroxy-2,2-dithien-3-ylacetox)-1-(2-phenoxyethyl)-1-azonia bicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 72 mg, 52%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55-1.65 (m, 1H), 1.7-1.8 (m, 1H), 1.85-2.05 (m, 2H), 2.3 (m, 1H), 3.2-3.6 (m, 5H), 3.7 (m, 2H), 4.05 (m, 1H), 4.4 (m, 2H), 5.2(m, 1H), 6.75 (s, OH), 6.95-7.05 (m, 3H), 7.1 (d, 2H), 7.3-7.5 (m, 6H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 470.

**Example 97**

25     **1-[3-(4-Fluorophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-3-ylacetox y)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 79 mg, 54%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55-1.65 (m, 1H), 1.7-1.8 (m, 1H), 1.85-2.0 (m, 2H), 2.05-2.2 (m, 2H), 2.3 (m, 1H), 3.1-3.2 (m, 1H), 3.25-3.55 (m, 6H), 3.85-3.95 (m, 1H), 4.0 (t, 2H), 5.2(m, 1H), 6.75 (s, OH), 6.95 (m, 2H), 7.15 (m, 4H), 7.4 (m, 2H), 7.5 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 502.

**Example 98**

35     **3(R)-(2-Hydroxy-2,2-dithien-3-ylacetox)-1-(3-phenylallyl)-1-azoniab**

**icyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 24 mg, 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.8 - 2.05 (m, 4H), 2.3 (m, 1H), 3.15 (m, 1H), 3.3 - 3.5 (m, 4H), 3.9 (m, 1H), 4.05 (m 2H), 5.25 (m, 1H), 6.35 (m, 1H), 6.75 (s, OH), 6.85 (t, 1H), 7.1 (m, 2H), 7.3-7.5 (m, 5H), 7.55 (m, 4H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 502.

**Example 99****1-(3-phenylallyl)-3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 400 mg, 93%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.35-1.50 (m, 1H), 1.60-1.75 (m, 1H), 1.75-1.95 (m, 2H), 2.10 (m, 1H), 2.85 (m, 1H), 3.10 (d, 1H), 3.20-3.50 (m, 3H), 3.85 (m, 1H), 4.0 (dd, 2H), 5.05 (m, 1H), 6.40 (dd, 1H), 6.80-6.90 (d, 1H), 6.85 (s, OH), 7.20-7.50 (m, 7H), 7.60 (m, 4H), 7.80 (m, 2H); MS [M-Br]<sup>+</sup>: 452; mp 146°C.

**Example 100****3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-(3-phenoxy-propyl)-1-azoniabicyclo[2.2.2] octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 690 mg, 83%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.47 (m, 1H), 1.68 (m, 1H), 1.87 (m, 2H), 2.1 (m, 3H), 2.89 (m, 1H), 3.15 (d, 1H), 3.4 (m, 5H), 3.9 (m, 1H), 4.0 (m, 2H), 5.04 (m, 1H), 6.85 (s, OH), 6.97 (m, 3H), 7.35 (m, 4H), 7.45 (m, 2H), 7.65 (m, 2H), 7.85 (m, 2H); MS [M-Br]<sup>+</sup>: 470; mp 108°C.

**Example 101****3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 170 mg, 74%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.45 (m, 1H), 1.65 (m, 1H), 1.85 (m, 2H), 2.1 (m, 1H), 2.9 (m, 3H), 3.15 (m, 1H), 3.3 - 3.5 (m, 5H), 3.85 (m, 1H), 5.05 (m, 1H), 6.85 (s, OH), 7.2 - 7.4 (m, 7H), 7.45 (t, 2H), 7.55 (d, 1H), 7.65 (d, 1H), 7.85 (d,

2H); MS [M-Br]<sup>+</sup>: 440; mp 118°C.

#### Example 102

3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-(2-phenoxyethyl)-1-  
5 azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods c and a. The  
yield of final step was 460 mg, 96%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.42 (m, 1H),  
1.66 (m, 1H), 1.80-1.88 (m, 2H), 2.08 (m, 1H), 2.93 (m, 1H), 3.25-3.60  
(m, 4H), 3.65 (m, 2H), 3.95 (m, 1H), 4.35 (m, 2H), 5.02 (m, 1H), 6.85  
10 (s, 1H, OH), 6.97 (d, 2H), 7.04 (t, 1H), 7.20-7.45 (m, 6H), 7.55-7.60  
(t, 2H), 7.80 (d, 2H); MS [M-Br]<sup>+</sup>: 456; mp 140°C.

#### Example 103

3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-(4-oxo-4-phenylbutyl)-  
15 -1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The  
yield of final step was 15 mg, 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.45 (m, 1H),  
1.65 (m, 1H), 1.7 - 2.0 (m, 4H), 2.1 (m, 1H), 2.75 (m, 1H), 3.0 -  
3.2 (m, 4H), 3.25 - 3.4 (m, 4H), 3.85 (m, 1H), 5.05 (m, 1H), 6.85  
20 (s, OH), 7.35 (t, 2H), 7.45 (t, 2H), 7.55 - 7.7 (m, 5H), 7.85 (d,  
2H), 8.0 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 482.

#### Example 104

1-[3-(4-Fluorophenoxy)propyl]-3(R)-(9-hydroxy-9[H]-fluorene-9-  
25 carbonyloxy)-1-azoniabicyclo[2.2.2]octane; chloride

The title compound was synthesised according to methods c and a. The  
yield of final step was 440 mg, 94%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H),  
1.65 (m, 2H), 1.7 - 1.95 (m, 2H), 2.0 - 2.1 (m, 3H), 2.8 (m, 1H),  
3.1 (d, 1H), 3.2 - 3.4 (m, 5H), 3.8 (m, 1H), 4.0 (t, 2H), 5.0 (m,  
30 1H), 6.85 (s, OH), 6.95 (m, 2H), 7.15 (t, 2H), 7.35 (t, 2H), 7.45  
(t, 2H), 7.55 (d, 1H), 7.65 (d, 1H), 7.85 (d, 2H); MS [M-Br]<sup>+</sup>: 488;  
mp 142°C.

#### Example 105

35 1-[3-(2,4-Difluorophenoxy)propyl]-3(R)-(9-hydroxy-9[H]-fluorene-9-



**carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 14 mg, 13%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.6 - 1.9 (m, 3H), 2.1 (m, 3H), 2.8 (m, 1H), 3.1 (d, 1H), 3.2 - 3.4 (m, 5H), 3.85 (m, 1H), 4.05 (t, 2H), 5.0 (m, 1H), 6.85 (s, OH), 7.05 (t, 1H), 7.15 - 7.4 (m, 4H), 7.45 (t, 2H), 7.55 (d, 1H), 7.65 (d, 1H), 7.85 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 506.

**Example 106**

10 **3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-(3-phenylaminopropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 14 mg, 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.6 (m, 1H), 1.8 (m, 4H), 2.05 (m, 1H), 2.7 (m, 1H), 3.0 (m, 3H), 3.2 - 3.4 (m, 6H), 3.8 (m, 1H), 5.0 (m, 1H), 5.6 (t, NH), 6.55 (m, 3H), 6.85 (s, OH), 7.1 (t, 2H), 7.35 (dd, 2H), 7.45 (dd, 2H), 7.55 (dd, 2H), 7.8 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 469.

**Example 107**

20 **3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-[3-(4-hydroxyphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 15 mg, 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.6 (m, 1H), 1.7 - 1.9 (m, 2H), 1.95 - 2.05 (m, 2H), 2.1 (m, 1H), 2.8 (m, 1H), 3.1 (d, 1H), 3.25 - 3.4 (m, 5H), 3.8 - 3.9 (m, 3H), 5.0 (m, 1H), 6.7 (d, 2H), 6.75 (d, 2H), 6.85 (s, OH), 7.35 (t, 2H), 7.45 (t, 2H), 7.55 (d, 1H), 7.65 (d, 1H), 7.85 (d, 2H), 9.0 (s, OH); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 486.

30 **Example 108**

**1-(2-Benzoyloxyethyl)-3(R)-(9-hydroxy-9[H]-fluorene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 470 mg, 96%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.7 - 1.9 (m, 2H), 2.1 (m, 1H), 2.9 (m, 1H), 3.15 -

3.5 (m, 6H), 3.75 (m, 2H), 3.85 (m, 1H), 4.5 (s, 2H), 5.0 (m, 1H), 6.85 (s, OH), 7.3 - 7.5 (m, 9H), 7.55 (m, 2H), 7.8 (d, 2H); MS [M-Br]<sup>+</sup>: 470; mp 86°C.

5     **Example 109**

**3(R)-(9-Hydroxy-9H-fluorene-9-carbonyloxy)-1-(3-thienyl-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 180 mg, 70%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.37 (m, 1H), 1.62 (m, 1H), 1.75-1.95 (m, 4H), 2.06 (m, 1H), 2.72 (m, 1H), 2.80 (m, 2H), 3.02-3.06 (m, 1H), 3.15-3.20 (m, 2H), 3.25-3.40 (m, 3H), 3.80 (m, 1H), 5.0 (m, 1H), 6.85 (s, 1H, OH), 6.95-7.0 (m, 2H), 7.25-7.50 (m, 5H), 7.55-7.65 (m, 2H), 7.85 (d, 2H); MS [M-Br]<sup>+</sup>: 460; mp 140°C.

15     **Example 110**

**3(R)-(9-Hydroxy-9H-fluorene-9-carbonyloxy)-1-(3-phenylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 80 mg, 40%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.35 (m, 1H), 1.6 (m, 1H), 1.7-1.90 (m, 2H), 2.05 (m, 1H), 2.5 (m, 2H), 2.7 (m, 1H), 3.0 (m, 1H), 3.15 (m, 2H), 3.2-3.4 (m, 3H), 3.75 (m, 1H), 5.0 (m, 1H), 6.85 (s, OH), 7.20-7.50 (m, 9H), 7.55 (dd, 2H), 7.85 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 454.

25     **Example 111**

**3(R)-(9-Hydroxy-9H-fluorene-9-carbonyloxy)-1-(4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 74 mg, 35%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.35 (m, 1H), 1.45-1.65 (m, 5H), 1.7-1.90 (m, 2H), 2.05 (m, 1H), 2.55-2.75 (m, 3H), 3.0 (m, 1H), 3.15 -3.45 (m, 5H), 3.75 (m, 1H), 5.0 (m, 1H), 6.85 (s, OH), 7.20 (m, 3H), 7.25 - 7.35 (m, 4H), 7.45-7.5 (m, 2H), 7.55-7.6 (dd, 2H), 7.85 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 468.

35     **Example 112**

**3(R)-(9-Hydroxy-9H-fluorene-9-carbonyloxy)-1-(2-thienyl-2-ylethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 79 mg, 39%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.8-1.95 (m, 2H), 2.1 (m, 1H), 2.9 (m, 1H), 3.1-3.25 (m, 4H), 3.15 -3.45 (m, 5H), 3.85 (m, 1H), 5.05 (m, 1H), 6.85 (s, OH), 7.0 (m, 2H), 7.35 (t, 2H), 7.45-7.5 (m, 3H), 7.55 (d, 1H), 7.65 (d, 1H), 7.85 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>-</sup>: 446.

**Example 113**

**3(R)-(9-Hydroxy-9H-fluorene-9-carbonyloxy)-1-(4-phenoxybutyl)-1-azoniabicyclo[2.2.2]octane: trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 72 mg, 33%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.55-1.9 (m, 7H), 2.05 (m, 1H), 2.7 (m, 1H), 3.0 (m, 1H), 3.15 -3.5 (m, 7H), 3.8 (m, 1H), 4.0 (m, 2H), 5.05 (m, 1H), 6.85 (s, OH), 6.95 (m, 3H), 7.25-7.35 (m, 4H), 7.4-7.45 (m, 2H), 7.6 (dd, 2H), 7.85 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 484.

20

**Example 114**

**3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(3-phenylallyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 200 mg, 76%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.54 (m, 1H), 1.70-1.86 (m, 3H), 1.76 (s, 3H), 2.13 (m, 1H), 3.06 (m, 1H), 3.20-3.50 (m, 4H), 3.86 (m, 1H), 4.05 (dd, 2H), 5.02 (m, 1H), 6.43 (dd, 1H), 6.86 (d, 1H), 7.26-7.46 (m, 7H), 7.58-7.65 (m, 3H), 7.70-7.72 (m, 1H), 7.87-7.90 (m, 2H); MS [M-Br]<sup>+</sup>: 450; mp 234°C.

30

**Example 115**

**3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 210 mg, 66%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H),

35

1.60-2.0 (m, 3H), 1.76 (s, 3H), 2.12 (m, 1H), 3.10-3.25 (m, 1H), 3.40-3.80 (m, 6H), 4.0 (m, 1H), 4.41 (m, 2H), 4.98 (m, 1H), 6.98-7.05 (m, 3H), 7.27-7.46 (m, 6H), 7.63-7.71 (m, 2H), 7.87-7.90 (m, 2H); MS [M-Br]<sup>+</sup>: 454; mp 202°C.

5

**Example 116**

**3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 210 mg, 61%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.60-2.0 (m, 3H), 1.78 (s, 3H), 2.0-2.20 (m, 3H), 3.0-3.10 (m, 1H), 3.25-3.53 (m, 6H), 3.86 (m, 1H), 4.03 (m, 2H), 4.98 (m, 1H), 6.95-7.0 (m, 3H), 7.30-7.48 (m, 6H), 7.65-7.92 (m, 4H); MS [M-Br]<sup>+</sup>: 468; mp 204°C.

15

**Example 117**

**3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 18 mg, 19%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65-1.95 (m, 3H), 1.75 (s, 3H), 2.15 (m, 1H), 2.9-3.1 (m, 4H), 3.25-3.55 (m, 5H), 3.85 (m, 1H), 5.05 (m, 1H), 7.25-7.55 (m, 9H), 7.65 (d, 1H), 7.75 (d, 1H), 7.95 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 438.

25

**Example 118**

**3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(4-oxo-4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg, 19%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65-2.05 (m, 5H), 1.75 (s, 3H), 2.1 (m, 1H), 3.0 (m, 1H), 3.1-3.5 (m, 8H), 3.85 (m, 1H), 7.35-7.5 (m, 4H), 7.55 (t, 2H), 7.65 (t, 2H), 7.7 (d, 1H), 7.9 (d, 2H), 8.0 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 480.

**Example 119**

**1-[3-(4-Fluorophenoxy)propyl]-3(R)-(9-methyl-9[H]-fluorene-9-**

35

**carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 23 mg, 23%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65 - 1.95 (m, 3H), 1.75 (s, 3H), 2.05 - 2.15 (m, 3H), 3.0 (m, 1H), 3.25 - 3.5 (m, 6H), 3.85 (m, 1H), 4.0 (t, 2H), 5.0 (m, 1H), 6.95 (m, 2H), 7.15 (t, 2H), 7.35 - 7.5 (m, 4H), 7.65 (d, 1H), 7.75 (d, 1H), 7.9 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 486.

**Example 120****1-[3-(2,4-Difluorophenoxy)propyl]-3(R)-(9-methyl-9H-fluorene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 20 mg, 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65 - 1.95 (m, 3H), 1.75 (s, 3H), 2.05 - 2.2 (m, 3H), 3.0 (m, 1H), 3.25 - 3.55 (m, 6H), 3.85 (m, 1H), 4.1 (t, 2H), 5.0 (m, 1H), 7.05 (t, 1H), 7.2 - 7.5 (m, 6H), 7.65 (d, 1H), 7.75 (d, 1H), 7.9 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 504.

**Example 121****3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(3-phenylaminopropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg, 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65 - 1.95 (m, 5H), 1.75 (s, 3H), 2.1 (m, 1H), 2.95 (m, 1H), 3.05 (m, 2H), 3.15 - 3.45 (m, 6H), 3.8 (m, 1H), 5.0 (m, 1H), 5.65 (t, NH), 6.6 (m, 3H), 7.1 (t, 2H), 7.35 - 7.55 (m, 4H), 7.65 (d, 1H), 7.75 (d, 1H), 7.9 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 467.

**Example 122****1-[3-(4-Hydroxyphenoxy)propyl]-3(R)-(9-methyl-9[H]-fluorene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 22 mg, 22%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65 - 1.9 (m, 3H), 1.75 (s, 3H), 2.0 - 2.15 (m, 3H), 3.0 (m, 1H), 3.25 - 3.5 (m, 6H), 3.8 - 3.95 (m, 3H), 5.0 (m, 1H), 6.7 (d, 1H),

6.75 (d, 1H), 7.35 - 7.45 (m, 4H), 7.65 (d, 1H), 7.75 (d, 1H), 7.9 (d, 2H), 9.0 (s, OH); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 484.

#### Example 123

5 1-(2-Benzoyloxyethyl)-3(R)-(9-methyl-9[H]-fluorene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods c and b. The yield of final step was 17 mg, 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65-1.95 (m, 4H), 1.75 (s, 3H), 2.15 (m, 1H), 3.1 (m, 1H), 3.3-3.55 (m, 6H), 3.8-3.95 (m, 3H), 4.5 (s, 2H), 5.0 (m, 1H), 7.3-7.5 (m, 9H), 7.6-7.7 (m, 2H), 7.9 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 468.

#### Example 124

15 3(R)-(9,10-Dihydroanthracene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods d and a. The yield of final step was 420 mg, 89%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.55 (m, 1H), 1.65-1.95 (m, 3H), 2.15 (m, 1H), 2.95 (m, 2H), 3.15 (m, 1H), 3.25-3.60 (m, 6H), 3.85 (m, 1H), 3.95-4.15 (dd, 2H, J<sub>1</sub>= 1.8 Hz, J<sub>2</sub>= 4.2Hz), 5.02 (m, 1H), 5.25 (s, 1H), 7.25-7.43 (m, 11H), 7.48-7.55 (m, 2H); MS [M-Br]<sup>+</sup>: 438; mp 216°C.

#### Example 125

25 3(R)-(9,10-Dihydroanthracene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods d and a. The yield of final step was 450 mg, 82%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.56 (m, 1H), 1.65-1.95 (m, 3H), 2.05-2.15 (m, 3H), 3.10 (m, 1H), 3.20-3.50 (m, 6H), 3.80 (m, 1H), 3.94-4.14 (m, 4H), 5.0 (m, 1H), 5.22 (s, 1H), 6.94-7.0 (m, 3H), 7.25-7.35 (m, 6H), 7.40 (m, 2H), 7.54-7.47 (m, 2H); MS [M-Br]<sup>+</sup>: 468; mp 157°C.

#### Example 126

35 1-(4-Phenylbutyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods d and a. The yield of final step was 83 mg , 21%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.50-2.0 (m, 8H), 2.15 (m, 1H), 2.65 (m, 2H), 3.05-3.65 (m, 7H), 3.80 (m, 1H), 5.0 (m, 1H), 5.30 (s, 1H), 7.10-7.45 (m, 11H), 7.45-7.60 (m, 2H); MS [M-Br]<sup>+</sup>: 468; mp 95°C.

#### Example 127

**1-(2-Phenoxyethyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo [2.2.2]octane; bromide**

The title compound was synthesised according to methods d and a. The yield of final step was 300 mg , 73%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.70-2.0 (m, 4H), 2.2 (m, 1H), 3.20-3.80 (m, 7H), 4.0 (m, 1H), 4.40 (m, 2H), 5.05 (m, 1H), 5.30 (s, 1H), 7.0-7.10 (m, 7H), 7.30-7.45 (m, 4H), 7.45-7.55 (m, 2H); MS [M-Br]<sup>+</sup>: 456; mp 200°C.

#### Example 128

**1-(3-Phenoxypropyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1- azoniabicyclo [2.2.2]octane; bromide**

The title compound was synthesised according to methods d and a. The yield of final step was 350 mg , 83%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.70-2.0 (m, 4H), 2.0-2.25 (m, 3H), 3.15-3.65 (m, 7H), 3.85-3.95 (m, 1H), 3.95-4.10 (m, 2H), 5.0 (m, 1H), 5.30 (s, 1H), 6.90-7.0 (m, 3H), 7.10-7.25 (m, 4H), 7.25-7.40 (m, 4H), 7.40-7.60 (m, 2H); MS [M-Br]<sup>+</sup>: 470; mp 184°C.

#### Example 129

**1-Phenethyl-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo [2.2.2]octane; bromide**

The title compound was synthesised according to methods d and a. The yield of final step was 100 mg, 44%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 4H), 2.1 (m, 1H), 2.9 - 3.05 (m, 2H), 3.15 - 3.6 (m, 7H), 3.85 (m, 1H), 5.05 (m, 1H), 5.3 (s, 1H), 7.15 - 7.55 (m, 13H); MS [M-Br]<sup>+</sup>: 440.

#### Example 130

**1-(4-Oxo-4-phenylbutyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azonia**

**bicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods d and b. The yield of final step was 16 mg, 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.05 (m, 6H), 2.1 (m, 1H), 3.1 - 3.55 (m, 9H), 3.8 (m, 1H), 5.05 (m, 1H), 5.25 (s, 1H), 7.1 - 7.3 (m, 4H), 7.35 (t, 2H), 7.45 - 7.6 (m, 4H), 7.7 (d, 1H), 8.0 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 482.

**Example 131****1-[3-(4-Fluorophenoxy)propyl]-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane, trifluoroacetate**

The title compound was synthesised according to methods d and b. The yield of final step was 18 mg, 18%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 - 2.1 (m, 6H), 2.15 (m, 1H), 3.1 - 3.5 (m, 7H), 3.8 (m, 1H), 4.0 (t, 2H), 5.0 (m, 1H), 5.3 (s, 1H), 6.95 (m, 2H), 7.1 - 7.3 (m, 6H), 7.4 (t, 2H), 7.5 (dd, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 488.

**Example 132****1-[3-(2,4-Difluorophenoxy)propyl]-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods d and b. The yield of final step was 14 mg, 14%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 1.95 (m, 4H), 2.05 - 2.2 (m, 3H), 3.1 - 3.55 (m, 7H), 3.8 (m, 1H), 4.05 (t, 2H), 5.0 (m, 1H), 5.3 (s, 1H), 7.05 (t, 1H), 7.1 - 7.55 (m, 10H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 506.

**Example 133****1-(3-Phenylaminopropyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods d and b. The yield of final step was 17 mg, 17%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 2.0 (m, 6H), 2.15 (m, 1H), 3.0 - 3.5 (m, 9H), 1.75 (m, 1H), 5.0 (m, 1H), 5.3 (s, 1H), 6.65 (t, NH), 6.55 (m, 3H), 7.05 - 7.3 (m, 6H), 7.35 - 7.55 (m, 4H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 469.

**Example 134**



1-[3-(4-Hydroxyphenoxy)propyl]-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods d and b. The yield of final step was 21 mg, 20%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.7 - 2.1 (m, 6H), 2.15 (m, 1H), 3.1 - 3.5 (m, 7H), 3.7 - 3.95 (m, 3H), 5.0 (m, 1H), 5.3 (s, 1H), 6.7 (d, 2H), 6.75 (d, 2H), 7.1 - 7.3 (m, 4H), 7.35 - 7.55 (m, 4H), 9.0 (s, OH); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 486.

#### Example 135

1-(2-Benzoyloxyethyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate

The title compound was synthesised according to methods d and b. The yield of final step was 16 mg, 16%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.65 - 1.95 (m, 4H), 2.1 (m, 1H), 3.1 - 3.9 (m, 10H), 4.5 (s, 2H), 5.0 (m, 1H), 5.3 (s, 1H), 7.15 (m, 4H), 7.3 - 7.5 (m, 7H), 7.55 (t, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 470.

#### Example 136

3(R)-(9-Hydroxy-9[H]-xanthene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods c and a. The yield of final step was 340 mg, 71%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.30 (m, 1H), 1.65 (m, 1H), 1.70-1.95 (m, 2H), 1.95-2.10 (m, 3H), 2.70 (m, 1H), 2.90 (m, 1H), 3.2-3.5 (m, 5H), 3.80 (m, 1H), 4.0 (t, 2H), 5.05 (m, 1H), 6.90-7.0 (m, 3H), 7.20-7.35 (m, 7H), 7.40-7.46 (m, 2H), 7.65-7.70 (m, 2H); MS [M-Br]<sup>+</sup>: 486; mp 219°C.

#### Example 137

3(R)-(9-Hydroxy-9[H]-xanthene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods c and a. The yield of final step was 290 mg, 64%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.32 (m, 1H), 1.65 (m, 1H), 1.70-1.95 (m, 2H), 2.1 (m, 1H), 2.75-2.90 (m, 3H), 3.05 (m, 1H), 3.30-3.50 (m, 5H), 3.82 (m, 1H), 5.05 (m, 1H), 7.20-7.40 (m, 10H), 7.40-7.50 (m, 2H), 7.65-7.70 (m, 2H); MS [M-Br]<sup>+</sup>: 456; mp

221°C.

**Example 138**

**3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 310 mg , 97%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.30 (m, 1H), 1.62 (m, 1H), 1.70-1.90 (m, 4H), 2.05 (m, 1H), 2.60 (m, 1H), 2.75-2.85 (m, 4H), 3.15 (m, 2H), 3.25-3.40 (m, 2H), 3.75 (m, 1H), 5.0 (m; 1H), 6.93 (m, 1H), 7.0 (m, 1H), 7.14-7.26 (m, 5H), 7.36-7.45 (m, 3H), 7.63-7.67 (m, 2H); MS [M-Br]<sup>+</sup>: 476; mp 111°C.

**Example 139**

**3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(3-phenylpropyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 85 mg , 41%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.30 (m, 1H), 1.65 (m, 1H), 1.70-1.95 (m, 2H), 2.05 (m, 1H), 2.5-2.6 (m, 2H), 2.80 (m, 1H), 3.05-3.75 (m, 7H), 5.05 (m, 1H), 7.1-7.45 (m, 12H), 7.65-7.70 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 470.

**Example 140**

**3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 84 mg , 38%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.30 (m, 1H), 1.4-1.85 (m, 7H), 2.05 (m, 1H), 2.5-2.6 (m, 2H), 2.80 (m, 1H), 3.05-3.4 (m, 6H), 3.7 (m, 1H), 5.05 (m, 1H), 7.15-7.35 (m, 10H), 7.4 (m, 1H), 7.65 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 484.

**Example 141**

**3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(2-thien-2-ylethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 81 mg , 39%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.30 (m, 1H),

1.6 (m, 1H), 1.7-1.9(m, 2H), 2.05 (m, 1H), 2.75(m, 1H), 3.0(m, 1H), 3.1-3.2 (m, 2H), 3.3-3.6 (m, 5H), 3.8 (m, 1H), 5.05 (m, 1H), 6.95-7.0 (m, 2H), 7.15-7.3 (m, 5H), 7.45 (m, 3H), 7.65 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 462.

5

**Example 142**

**3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(4-phenoxybutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 83 mg , 37%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.3 (m, 1H), 1.5-1.9 (m, 7H), 2.05 (m, 1H), 2.6 (m, 1H), 2.8 (m, 1H), 3.1-3.45 (m, 7H), 3.75 (m, 1H), 4.0 (m, 2H), 5.05 (m, 1H), 6.95-7.0 (m, 3H), 7.15-7.45 (m, 9H), 7.65 (m, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 500.

15

**Example 143**

**3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 102 mg , 48%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.3 (m, 1H), 1.55-1.95 (m, 3H), 2.05 (m, 1H), 2.8 (m, 1H), 3.1 (m, 1H), 3.35-3.65 (m, 5H), 3.9 (m, 1H), 4.35 (m, 2H), 5.05 (m, 1H), 6.95 (d, 2H), 7.0-7.1 (m, 2H), 7.2 (m, 4H), 7.3-7.45 (m, 4H), 7.6 (t, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 472.

25

**Exemple 144**

**1-[3-(4-Fluorophenoxy)propyl]-3(R)-(9-hydroxy-9H-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 99 mg , 44%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.3 (m, 1H), 1.6 (m, 1H), 1.7-2.0 (m, 4H), 2.05 (m, 1H), 2.7 (m, 1H), 2.9 (m, 1H), 3.2-3.5 (m, 5H), 3.75-3.85 (m, 1H), 3.95 (m, 2H), 5.0 (m, 1H), 6.95 (m, 2H), 7.1-7.3 (m, 7H), 7.45 (t, 2H), 7.65 (t, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 504.

35

**Exemple 145**

**3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(3-phenylallyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 25 mg, 12%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.25-1.30 (m, 1H), 1.55-1.95 (m, 3H), 2.10 (m, 1H), 2.65-2.75 (m, 1H), 2.9 (m, 1H), 3.25-3.50 (m, 2H), 3.75-3.8 (m, 1H), 3.95 (m, 2H), 4.2 (d, 1H), 5.0 (m, 1H), 6.35 (m, 1H), 6.80 (d, 1H), 7.05-7.50 (m, 8H), 7.60 (m, 4H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 468.

**Example 146**

**3(R)-(9-Methyl-9[H]-xanthene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods c and a. The yield of final step was 110 mg. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.75 - 1.95 (m, 2H), 1.9 (s, 3H), 2.05 - 2.15 (m, 3H), 1.8 (m, 1H), 3.15 (m, 2H), 3.25 - 3.5 (m, 5H), 3.85 (m, 1H), 4.0 (t, 2H), 5.05 (m, 1H), 6.95 - 7.0 (m, 3H), 7.15 - 7.2 (m, 4H), 7.3 - 7.4 (m, 4H), 7.45 (d, 1H), 7.55 (d, 1H); MS [M-Br]<sup>+</sup>: 484; mp 195°C.

**Example 147**

**3(R)-(9-Methyl-9[H]-xanthene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg, 20%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.8 - 1.95 (m, 2H), 1.9 (s, 3H), 2.15 (m, 1H), 2.8 - 2.95 (m, 3H), 3.15 (d, 1H), 3.3 - 3.5 (m, 5H), 4.9 (m, 1H), 5.1 (m, 1H), 7.15 (m, 4H), 7.25 - 7.4 (m, 7H), 7.45 (d, 1H), 7.55 (d, 1H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 454.

**Example 148**

**3(R)-(9-Methyl-9[H]-xanthene-9-carbonyloxy)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 24 mg, 24%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.8 - 1.95 (m, 2H), 1.9 (s, 3H), 2.15 (m, 1H), 2.95

(m, 1H), 3.25 (m, 1H), 3.4 - 3.65 (m, 5H), 3.85 (m, 1H), 4.35 (t, 2H), 5.05 (m, 1H), 6.95 (d, 2H), 7.05 (t, 2H), 7.15 (m, 3H), 7.25 - 7.45 (m, 6H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 470.

5     **Example 149**

**3(R)-(9-Methyl-9[H]-xanthene-9-carbonyloxy)-1-(4-oxo-4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg, 19%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.75 - 1.95 (m, 7H), 2.15 (m, 1H), 2.8 (m, 1H), 3.05 - 3.25 (m, 4H), 3.3 - 3.5 (m, 4H), 3.85 (m, 1H), 5.05 (m, 1H), 7.15 (m, 4H), 7.35 (t, 2H), 7.45 - 7.6 (m, 4H), 7.7 (t, 1H), 8.0 (d, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 496.

15     **Example 150**

**1-[3-(4-Fluorophenoxy)propyl]-3(R)-(9-methyl-9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 25 mg, 24%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.75 - 1.95 (m, 2H), 1.9 (s, 3H), 1.95 - 2.1 (m, 2H), 2.15 (m, 1H), 2.8 (m, 1H), 3.1 (d, 1H), 3.25 - 3.5 (m, 5H), 3.8 (m, 1H), 4.0 (t, 2H), 5.05 (m, 1H), 6.95 (m, 2H), 7.15 (m, 6H), 7.35 (t, 2H), 7.5 (dd, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 502.

25     **Example 151**

**1-[3-(2,4-Difluorophenoxy)propyl]-3(R)-(9-methyl-9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 16 mg, 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.75 - 1.95 (m, 2H), 1.9 (s, 3H), 2.0 - 2.15 (m, 3H), 2.8 (m, 1H), 3.1 (d, 1H), 7.05 (t, 1H), 7.1 - 7.4 (m, 8H), 7.5 (dd, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 520.

**Example 152**

35     **3(R)-(9-Methyl-9[H]-xanthene-9-carbonyloxy)-1-(3-phenylaminopropyl)-**

**1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 16 mg, 15%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.35 (m, 1H), 1.6 (m, 1H), 1.7 - 1.9 (m, 4H), 1.9 (s, 3H), 2.1 (m, 1H), 2.7 (m, 1H), 2.95 - 3.05 (m, 3H), 3.1 - 3.4 (m, 6H), 3.75 (m, 1H), 5.0 (m, 1H), 5.6 (m, 1H), 6.55 (m, 3H), 7.05 - 7.15 (m, 6H), 7.3 (m, 2H), 7.45 (t, 2H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 483.

**Example 153****1-[3-(4-Hydroxyphenoxy)propyl]-3(R)-(9-methyl-9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 19 mg, 18%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 2.75 - 2.05 (m, 4H), 1.9 (s, 3H), 2.15 (m, 1H), 2.8 (m, 1H), 3.1 (d, 1H), 3.25 - 3.5 (m, 5H), 3.8 - 3.95 (m, 3H), 5.05 (m, 1H), 6.65 - 6.8 (m, 4H), 7.2 (m, 4H), 7.35 (t, 2H), 7.5 (m, 2H), 9.0 (s, OH); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 500.

**Example 154****1-(2-Benzyloxyethyl)-3(R)-(9-methyl-9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate**

The title compound was synthesised according to methods c and b. The yield of final step was 14 mg, 14%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.4 (m, 1H), 1.65 (m, 1H), 1.75 - 1.95 (m, 2H), 1.9 (s, 3H), 2.1 (m, 1H), 2.9 (m, 1H), 3.2 - 3.5 (m, 6H), 3.75 - 3.95 (m, 3H), 4.5 (s, 2H), 5.05 (m, 1H), 7.15 (m, 4H), 7.3 - 7.5 (m, 9H); MS [M-CF<sub>3</sub>COO]<sup>+</sup>: 484.

**Example 155****1-(3-Phenoxypropyl)-3(R)-(9[H]-thioxanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods d and a. The yield of final step was 323 mg, 50%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.35 (m, 1H), 1.65 (m, 1H), 1.70-1.95 (m, 2H), 2.0-2.2 (m, 3H), 2.75-2.90 (m, 1H), 3.12 (m, 1H), 3.25-3.50 (m, 5H), 3.80 (m, 1H), 4.0 (t, 2H), 5.0 (m, 1H), 5.6 (s, 1H), 6.94-7.0 (m, 3H), 7.22-7.41 (m, 6H),

7.45-7.64 (m, 4H); MS [M-Br]<sup>+</sup>: 486; mp 157°C.

**Example 156**

1-(3-phenylallyl)-3(R)-(10,11-Dihydro-5H-dibenzo[a,d]cycloheptene-5-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods d and a. The yield of final step was 250 mg, 94%. <sup>1</sup>H-NMR (CDCl<sub>3</sub>): δ 1.50-1.60 (m, 1H), 1.60-1.80 (m, 1H), 1.90 (m, 2H), 2.30 (m, 1H), 2.65-2.80 (m, 2H), 2.90-3.20 (m, 3H), 3.50 (d, 1H), 3.60-3.90 (m, 3H), 4.20 (m, 1H), 4.35-4.60 (double dd, 2H), 5.10 (m, 1H), 5.15 (s, 1H), 6.05 (dd, 1H), 6.90-7.0 (m, 2H), 7.0-7.5 (m, 11H); MS [M-Br]<sup>+</sup>: 464; mp 132°C.

**Example 157**

1-(3-phenoxypropyl)-3(R)-(10,11-Dihydro-5H-dibenzo[a,d]cycloheptene-5-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods d and a. The yield of final step was 290 mg, 94%. <sup>1</sup>H-NMR (CDCl<sub>3</sub>): δ 1.45-1.60 (m, 1H), 1.65-1.80 (m, 1H), 1.80-2.0 (m, 2H), 2.0-2.20 (m, 3H), 2.80-3.0 (m, 3H), 3.15-3.30 (m, 2H), 3.30-3.45 (d, 1H), 3.45-3.80 (m, 5H), 3.85-4.0 (m, 2H), 4.20 (m, 1H), 5.10 (m, 1H), 5.20 (s, 1H), 6.80-6.90 (d, 2H), 6.90-7.0 (t, 1H), 7.10-7.30 (m, 8H), 7.40 (m, 2H); MS [M-Br]<sup>+</sup>: 482; mp 182°C.

**Example 158**

3(R)-(5[H]-Dibenzo[a,d]cycloheptene-5-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

The title compound was synthesised according to methods d and a. The yield of final step was 180 mg, 56%. <sup>1</sup>H-NMR (DMSO-d<sub>6</sub>): δ 1.2 (m, 1H), 1.6 (m, 1H), 1.7 - 1.9 (m, 2H), 1.95 (m, 1H), 2.1 (m, 2H), 2.8 (m, 1H), 2.95 (d, 1H), 3.25 - 3.45 (m, 5H), 3.8 (m, 1H), 4.05 (t, 2H), 4.9 (m, 1H), 5.45 (s, 1H), 6.9 - 7.1 (m, 5H), 7.3 - 7.5 (m, 9H), 7.55 (d, 2H); MS [M-Br]<sup>+</sup>: 480; mp 111°C.

**Example 159**

3(R)-(5[H]-Dibenzo[a,d]cycloheptene-5-carbonyloxy)-1-phenethyl-1-

**azoniabicyclo[2.2.2]octane; bromide**

The title compound was synthesised according to methods d and a. The yield of final step was 210 mg, 68%. <sup>1</sup>H- NMR (DMSO-d<sub>6</sub>): δ 1.2 (m, 1H), 1.7 - 1.9 (m, 2H), 2.0 (m, 1H), 2.85 - 3.1 (m, 4H), 3.3 - 3.5 (m, 5H), 3.85 (m, 1H), 4.95 (m, 1H), 5.45 (s, 1H), 7.05 (m, 2H), 7.25 - 7.5 (m, 11H), 7.55 (m, 2H); MS [M-Br]<sup>+</sup>: 450; mp 248°C.

The Examples 160 to 164 illustrate pharmaceutical compositions according to the present invention and procedure for their preparation.

**Example 160****Preparation of a pharmaceutical composition: tablets****Formulation:**

Compound of the present invention .....	5.0 mg
Lactose.....	113.6 mg
Microcrystalline cellulose.....	28.4 mg
Light silicic anhydride.....	1.5 mg
Magnesium stearate.....	1.5 mg

Using a mixer machine, 15 g of the compound of the present invention was mixed with 340.8 g of lactose and 85.2 g of microcrystalline cellulose. The mixture was subjected to compression moulding using a roller compactor to give a flake-like compressed material. The flake-like compressed material was pulverized using a hammer mill, and the pulverized material was screened through a 20 mesh screen. A 4.5 g portion of light silicic anhydride and 4.5 g of magnesium stearate were added to the screened material and mixed. The mixer product was subjected to a tablets making machine equipped with a die/punch system of 7.5 mm in diameter, thereby obtaining 3,000 tablets each having 150 mg in weight.

**Example 161****Preparation of a pharmaceutical composition: tablets coated****Formulation:**

Compound of the present invention.....	5.0 mg
--	--------



Lactose.....95.2 mg  
 Corn starch.....40.8 mg  
 Polyvinylpyrrolidone K25..... 7.5 mg  
 Magnesium stearate..... 1.5 mg  
 5 Hydroxypropylcellulose..... 2.3 mg  
 Polyethylene glycol 6000..... 0.4 mg  
 Titanium dioxide..... 1.1 mg  
 Purified talc..... 0.7 mg

- 10 Using a fluidized bed granulating machine, 15 g of the compound of the present invention was mixed with 285.6 g of lactose and 122.4 g of corn starch. Separately, 22.5 g of polyvinylpyrrolidone was dissolved in 127.5 g of water to prepare a binding solution. Using a fluidized bed granulating machine, the binding solution was sprayed on the above  
 15 mixture to give granulates. A 4.5 g portion of magnesium stearate was added to the obtained granulates and mixed. The obtained mixture was subjected to a tablet making machine equipped with a die/punch biconcave system of 6.5 mm in diameter, thereby obtaining 3,000 tablets, each having 150 mg in weight.
- 20 Separately, a coating solution was prepared by suspending 6.9 g of hydroxypropylmethylcellulose 2910, 1.2 g of polyethylene glycol 6000, 3.3 g of titanium dioxide and 2.1 g of purified talc in 72.6 g of water. Using a High Coated, the 3,000 tablets prepared above were coated with the coating solution to give film-coated tablets, each  
 25 having 154.5 mg in weight.

#### **Example 162**

##### **Preparation of a pharmaceutical composition: liquid inhalant**

##### **Formulation:**

- 30 Compound of the present invention.....400  $\mu$ g  
 Physiological saline..... 1 ml

- A 40 mg portion of the compound of the present invention was dissolved in 90 ml of physiological saline, and the solution was adjusted to a  
 35 total volume of 100 ml with the same saline solution, dispensed in 1

ml portions into 1 ml capacity ampoule and then sterilized at 115° for 30 minutes to give liquid inhalant.

**Example 163**

5 **Preparation of a pharmaceutical composition: powder inhalant**

Formulation:

Compound of the present invention..... 200 µg

Lactose.....4,000 µg

10 A 20 g portion of the compound of the present invention was uniformly mixed with 400 g of lactose, and a 200 mg portion of the mixture was packed in a powder inhaler for exclusive use to produce a powder inhalant.

15 **Example 164**

**Preparation of a pharmaceutical composition: inhalation aerosol.**

Formulation:

Compound of the present invention..... 200 µg

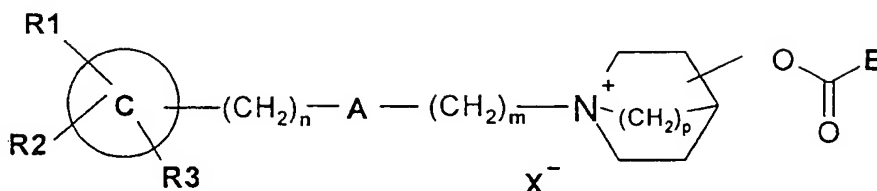
Dehydrated (Absolute) ethyl alcohol USP..... 8,400 µg

20 1,1,1,2-Tetrafluoroethane (HFC-134A).....46,810 µg

The active ingredient concentrate is prepared by dissolving 0.0480 g of the compound of the present invention in 2.0160 g of ethyl alcohol. The concentrate is added to an appropriate filling apparatus. The  
25 active ingredient concentrate is dispensed into aerosol container, the headspace of the container is purged with Nitrogen or HFC-134A vapor (purging ingredients should not contain more than 1 ppm oxygen) and is sealed with valve. 11.2344 g of HFC-134A propellant is then pressure  
30 filled into the sealed container.

CLAIMS

1. A compound according to formula (I)

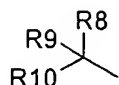


(I)

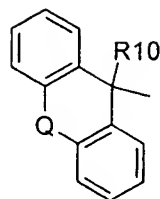
5 wherein:

- © is a phenyl ring, a  $C_4$  to  $C_9$  heteroaromatic compound containing one or more heteroatoms or a naphthalenyl, 5,6,7,8-tetrahydronaphthalenyl or biphenyl group;
- $R^1$ ,  $R^2$  and  $R^3$  each independently represent a hydrogen atom or halogen atom, or a hydroxy group, or a phenyl,  $-OR^4$ ,  $-SR^4$ ,  $-NR^4R^5$ ,  $-NHCOR^4$ ,  $-CONR^4R^5$ ,  $-CN$ ,  $-NO_2$ ,  $-COOR^4$  or  $-CF_3$  group, or a straight or branched lower alkyl group which may optionally be substituted, for example, with a hydroxy or alkoxy group, wherein  $R^4$  and  $R^5$  each independently represent a hydrogen atom, straight or branched lower alkyl group or together form an alicyclic ring; or  $R^1$  and  $R^2$  together form an aromatic, alicyclic or heterocyclic ring,
- $n$  is an integer from 0 to 4;
- $A$  represents a  $-CH_2-$ ,  $-CH=CR^6-$ ,  $-CR^6=CH-$ ,  $-CR^6R^7-$ ,  $-CO-$ ,  $-O-$ ,  $-S-$ ,  $-S(O)-$ ,  $SO_2$  or  $-NR^6-$  group, wherein  $R^6$  and  $R^7$  each independently represent a hydrogen atom, straight or branched lower alkyl group or  $R^6$  and  $R^7$  together form an alicyclic ring;
- $m$  is an integer from 0 to 8; provided that when  $m = 0$ ,  $A$  is not  $-CH_2-$ ;
- $p$  is an integer from 1 to 2 and the substitution in the azoniabicyclic ring may be in the 2, 3 or 4 position including all possible configurations of the asymmetric carbons;
- $B$  represents a group of formula i) or ii):

i)

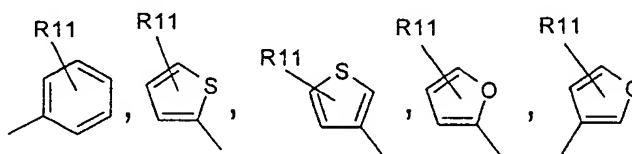


ii)



wherein  $R^{10}$  represents a hydrogen atom, a hydroxy or methyl group; and  $R^8$  and  $R^9$  each independently represent

5



wherein  $R^{11}$  represents a hydrogen or halogen atom or a straight or branched lower alkyl group and Q represents a single bond,  $-CH_2-$ ,  $-CH_2-CH_2-$ ,  $-O-$ ,  $-O-CH_2-$ ,  $-S-$ ,  $-S-CH_2-$  or  $-CH=CH-$ ; and X represents a pharmaceutically acceptable anion of a mono or polyvalent acid.

2. A compound according to claim 1, wherein any alkyl group present as  $R^1$  to  $R^7$  or  $R^{11}$  contains from 1 to 4 carbon atoms.

3. A compound according to claim 1 or 2 wherein  $p=2$ .

4. A compound according to any one of the preceding claims wherein © represents a phenyl, pyrrolyl, thienyl, furyl, biphenyl, naphthalenyl, 5,6,7,8-tetrahydronaphthalenyl, benzo[1,3]dioxolyl, imidazolyl or benzothiazolyl group.

5. A compound according to claim 4, wherein © represents a phenyl, pyrrolyl or thienyl group.

6. A compound according to any one of the preceding claims wherein  $R^1$ ,  $R^2$  and  $R^3$  each independently represent a hydrogen or halogen atom or a hydroxy, methyl, tert-butyl,  $-CH_2OH$ , 3-hydroxypropyl,  $-OMe$ ,  $-NMe_2$ ,  $-NHCOMe$ ,  $-CONH_2$ ,  $-CN$ ,  $-NO_2$ ,  $-COOMe$  or  $-CF_3$  group.

7. A compound according to claim 6 wherein  $R^1$ ,  $R^2$  and  $R^3$  each independently represent a hydrogen or halogen atom or a hydroxy group.

8. A compound according to claim 7, wherein the halogen atom is fluorine.

9. A compound according to any one of the preceding claims wherein A represents a  $-\text{CH}_2-$ ,  $-\text{CH}=\text{CH}-$ ,  $-\text{CO}-$ ,  $-\text{NH}-$ ,  $-\text{NMe}-$ ,  $-\text{O}-$  or  $-\text{S}-$  group; n is 0 or 1; and m is an integer from 1 to 6.

10. A compound according to claim 9, wherein A represents a  $-\text{CH}_2-$ ,  $-\text{CH}=\text{CH}-$  or  $-\text{O}-$  group and m is 1, 2 or 3.

11. A compound according to any one of the preceding claims wherein the azoniabicyclo group is substituted on the nitrogen atom with a 3-phenoxypropyl, 2-phenoxyethyl, 3-phenylallyl, phenethyl, 3-phenylpropyl, 4-phenylbutyl, 3-(2-hydroxyphenoxy)propyl, 3-(4-fluorophenoxy)propyl, 2-benzyloxyethyl, 3-pyrrol-1-ylpropyl, 2-thien-2-ylethyl or 3-thien-2-ylpropyl group.

12. A compound according to any one of the preceding claims wherein B represents a group of formula (i) and  $\text{R}^8$  and  $\text{R}^9$  each independently represent a phenyl, 2-thienyl, 3-thienyl, 2-furyl, or 3-furyl group and  $\text{R}^{11}$  represents a hydrogen atom.

13. A compound according to any one of claims 1 to 11, wherein B represents a group of formula (ii) and Q represents a single bond, a  $-\text{CH}_2-$ ,  $-\text{CH}_2-\text{CH}_2-$  group or an oxygen atom.

14. A compound according to any one of the preceding claims wherein X represents a bromide, chloride or trifluoroacetate anion.

15. A compound according to any one of the preceding claims wherein the azoniabicyclo group is substituted in the 3-position.

16. A compound according to claim 15, wherein the substituent in the 3 position has (R) configuration.

17. A compound according to claim 16, wherein  $\text{R}^8$  is different from  $\text{R}^9$  in group i), and the asymmetric carbon to which  $\text{R}^8$  and  $\text{R}^9$  are bonded has the (R) configuration.

18. A compound according to claim 16, wherein  $\text{R}^8$  is different from  $\text{R}^9$  in group i), and the asymmetric carbon to which  $\text{R}^8$  and  $\text{R}^9$  are bonded has the (S) configuration.

19. A compound according to any one of the preceding claims which is a single isomer.

20. A compound according to claim 1 which is

- 3(R)-Diphenylacetoxy-1-(3-phenoxy-propyl)-1-azoniabicyclo[2.2.2]octane;  
bromide
- 3(R)-(2-Hydroxy-2,2-diphenyl-acetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 5 3(R)-(2,2-Diphenylpropionyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Hydroxy-2-phenyl-2-thien-2-yl-acetoxy)-1-(3-phenoxypropyl)-1-azonia-bicyclo[2.2.2]octane; bromide
- 3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-(3-phenylallyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 10 3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-(2-phenoxyethyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Furan-2-yl-2-hydroxy-2-phenylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 15 3(R)-(2,2-Dithien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Hydroxy-2,2-di-thien-2-ylacetoxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide
- 3(R)-(2-Hydroxy-2,2-di-thien-2-ylacetoxy)-1-(4-phenylbutyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 20 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 1-[3-(4-Fluorophenoxy)propyl]-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2]octane; chloride
- 25 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-[3-(2-hydroxyphenoxy)propyl]-1-azoniabicyclo[2.2.2]octane; trifluoroacetate
- 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-pyrrol-1-ylpropyl)-1-azonia-bicyclo[2.2.2]octane; trifluoroacetate
- 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(2-thien-2-ylethyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 30 3(R)-(2-Hydroxy-2,2-dithien-2-ylacetoxy)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; bromide
- 1-(2-Benzylxyethyl)-3(R)-(2-hydroxy-2,2-dithien-2-ylacetoxy)-1-azoniabicyclo[2.2.2]octane; trifluoroacetate
- 35 3(R)-(2-Hydroxy-2,2-dithien-3-ylacetoxy)-1-(3-phenoxypropyl)-1-azoni

abicyclo[2.2.2]octane; bromide

1-(3-phenylallyl)-3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide

5 3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

3(R)-(9-Hydroxy-9[H]-fluorene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide

3(R)-(9-Hydroxy-9H-fluorene-9-carbonyloxy)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; bromide

10 3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(3-phenylallyl)-1-azoniabicyclo[2.2.2]octane; bromide

3(R)-(9-Methyl-9[H]-fluorene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

15 1-(4-Phenylbutyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide

1-(2-Phenoxyethyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide

1-(3-Phenoxypropyl)-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide

20 1-Phenethyl-3(R)-(9[H]-xanthene-9-carbonyloxy)-1-azoniabicyclo[2.2.2]octane; bromide

3(R)-(9-Hydroxy-9[H]-xanthene-9-carbonyloxy)-1-(3-phenoxypropyl)-1-azoniabicyclo[2.2.2]octane; bromide

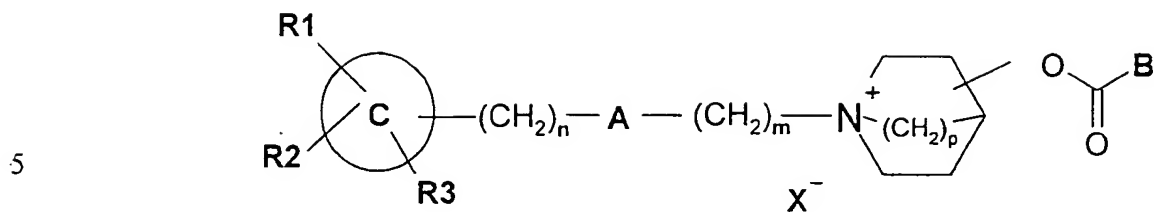
25 3(R)-(9-Hydroxy-9[H]-xanthene-9-carbonyloxy)-1-phenethyl-1-azoniabicyclo[2.2.2]octane; bromide

3(R)-(9-Hydroxy-9H-xanthene-9-carbonyloxy)-1-(3-thien-2-ylpropyl)-1-azoniabicyclo[2.2.2]octane; bromide or

3(R)-(9-Methyl-9[H]-xanthene-9-carbonyloxy)-1-(3-phenoxy-propyl)-1-azonia-bicyclo[2.2.2]octane; bromide

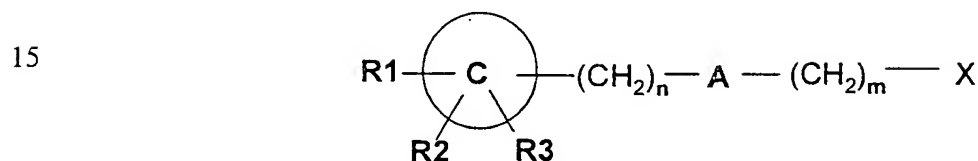
30 21. A compound according to any one of the preceding claims characterised in that it has an IC<sub>50</sub> value for muscarinic M<sub>3</sub> receptors (Hm3) of less than 35 nM.

22. A process for the preparation of a compound of formula (I)



10 (I)

which comprises reacting an alkylating agent of formula (II)



(II)

20

with a compound of formula (III)



(III)

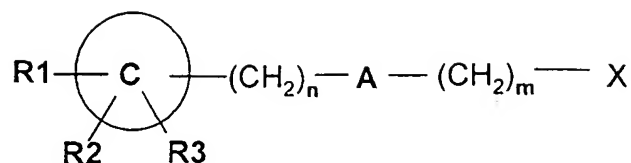
30 wherein, in each of formulae I, II and III, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, C, A, X, B, n, m and p are as defined in any one of claims 1 to 20.

23. A process according to claim 22 characterised in that the resulting reaction mixture is purified by solid phase extraction.

24. A compound of formula (II)

35

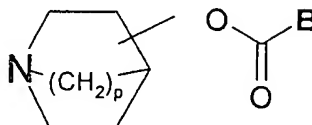




(II)

wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, ©, A, X, n and m are as defined in any one of claims 1, 2, 4 to 11, 14 or 20.

25. A compound of formula (III)



(III)

wherein B and p are as defined in any one of claims 1 to 3, 12, 13 or 15 to 20.

26. A compound according to claim 25 which is

9-Methyl-9[H]-fluorene-9-carboxylic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester;

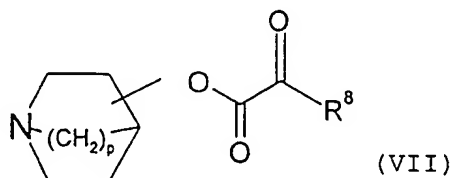
9-Methyl-9[H]-xanthene-9-carboxylic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester;

2-Hydroxydithien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-4-yl ester;

or

2-Hydroxy-2,2-difuran-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.

27. A compound of formula (VII)



(VII)

wherein p and R<sup>8</sup> are as defined in any one of claims 1 to 3 or 12.

28. A compound according to claim 27, wherein R<sup>8</sup> is a 2-thienyl or 2-furyl group.

29. A compound according to claim 27 which is  
Oxothien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-4-yl ester;  
5 Oxothien-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester; or  
Oxofuran-2-yl-acetic acid 1-azabicyclo[2.2.2]oct-3(R)-yl ester.

30. Use of a compound according to any one of claims 24 to 29  
in a process for producing a compound of formula (I) as defined in  
any one of claims 1 to 20.

10 31. A pharmaceutical composition comprising a compound  
according to any one of claims 1 to 21 in admixture with a  
pharmaceutically acceptable carrier or diluent.

32. A compound according to any one of claims 1 to 21, or a  
pharmaceutical composition according to claim 31 for use in a method  
15 of treatment of the human or animal body by therapy.

33. Use of a compound according to any one of claims 1 to 21,  
or a pharmaceutical composition according to claim 31 for the  
manufacture of a medicament for use in the treatment of respiratory,  
urinary or gastrointestinal disease.

20 34. Use of a compound according to any one of claims 1 to 21  
or a pharmaceutical composition according to claim 31 for the  
manufacture of a medicament for use in the treatment of COPD,  
chronic bronchitis, asthma and rhinitis.

35. A method for treating respiratory, urinary and/or  
25 gastrointestinal disease which method comprises administering to a  
human or animal patient in need of such treatment an effective  
amount of a compound according to any one of claims 1 to 21 or of a  
pharmaceutical composition according to claim 31.

30

35

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
18 January 2001 (18.01.2001)

PCT

(10) International Publication Number  
WO 01/04118 A3(51) International Patent Classification<sup>7</sup>: C07D 453/02,  
A61K 31/435, A61P 43/00(74) Agent: GOLDIN, Douglas, Michael; J.A. Kemp & Co.,  
14 South Square, Gray's Inn, London WC1R 5EU (GB).

(21) International Application Number: PCT/EP00/06469

(22) International Filing Date: 7 July 2000 (07.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
P 9901580 14 July 1999 (14.07.1999) ES(71) Applicant (for all designated States except US): ALMI-  
RALL PRODESFARMA S.A. [ES/ES]; General Mitre,  
151, E-08022 Barcelona (ES).

(72) Inventors; and

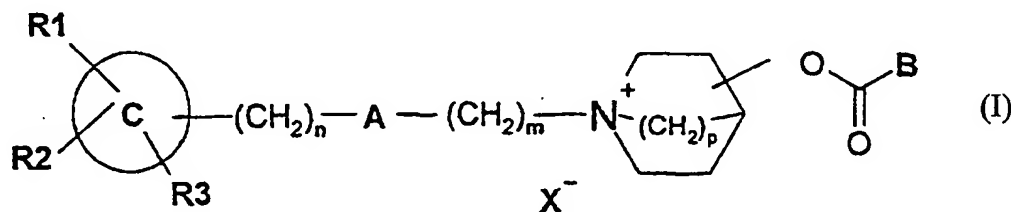
(75) Inventors/Applicants (for US only): FERNANDEZ  
FORNER, Dolors [ES/ES]; Roget de Flor, 221, 5<sup>o</sup>-4<sup>a</sup>,  
E-08025 Barcelona (ES). PRAT QUINONES, Maria  
[ES/ES]; Andrea Doria, 2, 1<sup>o</sup>-1<sup>a</sup>, E-08003 Barcelona (ES).  
BUIL ALBERO, Maria Antonia [ES/ES]; Calle Paris,  
50, 1<sup>o</sup>-4<sup>a</sup>, E-08029 Barcelona (ES).(81) Designated States (national): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,  
DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR,  
HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,  
LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ,  
NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM,  
TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.(84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,  
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

(88) Date of publication of the international search report:  
19 July 2001For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: QUINUCLIDINE DERIVATIVES AND THEIR USE AS MUSCARINIC M3 RECEPTOR LIGANDS

(57) Abstract: A compound according to formula (I) wherein z<sup>+</sup> is a phenyl ring, a C<sub>4</sub> to C<sub>9</sub> heteroaromatic compound containing one or more heteroatoms, or a naphthalenyl, 5,6,7,8-tetrahydronaphthalenyl or biphenyl group; which shows high affinity for muscarinic M<sub>3</sub> receptors (Hm3).

WO 01/04118 A3

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/06469

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07D453/02 A61K31/435 A61P43/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07D A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

CHEM ABS Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 424 021 A (PFIZER LTD.) 24 April 1991 (1991-04-24) page 2; claim 1	1,33
A	--- CHEMICAL ABSTRACTS, vol. 104, no. 19, 12 May 1986 (1986-05-12) Columbus, Ohio, US; abstract no. 168339g, GODOVIKOV, N. N. ET AL.: "Synthesis and muscarinolytic activity of quinuclidinyl benzilate alkyl iodides" XP002128290 abstract & KHIM.-FARM. ZH., vol. 19, no. 9, - 1985 pages 1060-1061, --- -/--	1



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

4 January 2001

Date of mailing of the international search report

30/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.  
Fax: (+31-70) 340-3016

Authorized officer

Van Bijlen, H

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 00/06469

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>FR 2 012 964 A (SOCIÉTÉ GÉNÉRALE DE RECHERCHES &amp; D'APPLICATIONS SCIENTIFIQUES) 27 March 1970 (1970-03-27) cited in the application claims</p> <p>-----</p>	1,33

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 00/06469

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 424021 A	24-04-1991	AT 102198 T	15-03-1994
		AU 616362 B	24-10-1991
		AU 6472690 A	25-07-1991
		CA 2027896 A	20-04-1991
		CN 1051041 A, B	01-05-1991
		DE 69007009 D	07-04-1994
		DE 69007009 T	09-06-1994
		HU 56365 A, B	28-08-1991
		JP 3133980 A	07-06-1991
		JP 6000780 B	05-01-1994
		KR 9304845 B	09-06-1993
		NO 174256 B	27-12-1993
		NZ 235750 A	26-03-1992
		PL 287365 A	03-06-1991
		PT 95610 A	13-09-1991
		RU 2005721 C	15-01-1994
		US 5171744 A	15-12-1992
		ZA 9008343 A	24-06-1992
FR 2012964 A	27-03-1970	AT 291272 B	15-06-1971
		BE 735031 A	01-12-1969
		CH 513174 A	30-09-1971
		DE 1935751 A	26-02-1970
		GB 1219606 A	20-01-1971
		NL 6910859 A, B	19-01-1970
		SE 361314 B	29-10-1973
		US 3714357 A	30-01-1973